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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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VOLUME 54 **JULY 1951** NUMBER 643

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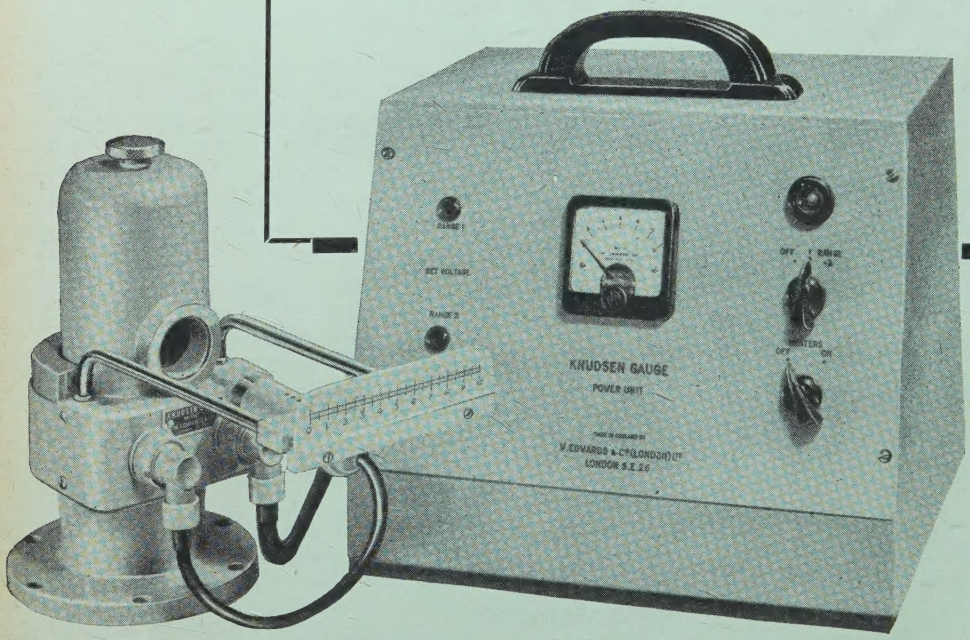

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Photocells
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Cathode-ray tubes
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Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Acta Chem. Scand.*	*Acta Chemica Scandinavica.* Einar Munksgaard, Copenhagen.
**Brit. Res. Rep.*	*British Research Reports.* Technical Information and Documents Unit, Lacon House, Theobalds Road, London, W.C.1.
**Energetika*	*Energetika.* Panska 2, Prague II.
Harvard Coll. Obs. Tech. Rep.	*Harvard College Observatory Technical Report.* Cambridge, Massachusetts. [Change of title.]
Indian East. Engr	*Indian and Eastern Engineer.* P.O. Box 2348, Calcutta; 39 Lombard Street, London, E.C.3.
Ingegnere	*L'Ingegnere.* Organo dell'Associazione Nazionale Ingegneri ed Architetti Italiani, Via delle Terme 90, Rome.
J. Sci. Industr. Res.	*Journal of Scientific and Industrial Research.* Hillside Road, Pusa, Delhi–5. [Change of address.]
K. Danske Vidensk. Selsk. Mat-fys. Medd.	*Det Kgl. Danske Videnskabernes Selskab, Matematisk-fysiske Meddelelser.* Ny Vestergade 23, Copenhagen 5. [Change of address.]
**Off. Tech. Serv. Wash., Rep.*	*Office of Technical Services, Reports.* Department of Commerce, Washington 25, D.C. [Available as photostat, microfilm, or mimeographed.]
**Overseas Res. Rep.*	*Overseas Research Report.* Technical Information and Documents Unit, Department of Scientific and Industrial Research, Lacon House, Theobalds Road, London, W.C.1. [Available as microfilm.]
**Pop. Astron.*	*Popular Astronomy.* Carleton College, Northfields, Minnesota.
**Proc. Japan Acad.*	*Proceedings of the Japan Academy.* C/o Science Council of Japan, Ueno Park, Tokyo.
Publ. Sci. Ass. Oceanogr. Phys.	*Publication Scientifique d'Association d'Océanographie Physique.* [Union Géodésique et Géophysique Internationale.] Prof. H. Mosby, Det Geophysiske Institutt, Bergen. [Change of address.]
QST	*QST.* American Radio Relay League, 38 LaSalle Road, West Hartford, Connecticut.
Tôhoku Math. J.	*Tôhoku Mathematical Journal.* Mathematical Institute, Tôhoku University, Sendai. [Change of address.]

New Journals

Acta Tech. Hungarica	*Acta Technica Hungarica.* Academiae Scientiarum Hungaricae, Sztalin-ut 31, Budapest VI. Vol. 1, No. 1 dated 1950. "On the average, one volume per year"; parts per volume not stated. Subscription 60 forints per volume.

Errata

Author Index (1950), p. 1154. PRASAD, M., DHARMATTI, S. S., KANEKAR, C. R., and BIRADAR, N. S.: *for* 1869 *read* 1069.

Abstr. 3520 (1951), line 8: *for* 6 × 10 V/cm *read* 6×10^2 V/cm.

MATHEMATICS 51

513.76

4993. An epitomisation of the basic theory of the Schwarz–Christoffel transformations as used in applied physics. T. J. HIGGINS. Letter in *J. Appl. Phys.*, **22**, 365–6 (*March*, 1951).

States the functions of a complex variable which map regions bounded by rectilinear polygons on the upper half-plane. References are given for the mapping of regions bounded by arcs of circles.

S. MICHAELSON

517.544.2

4994. Notes on conditional stationary Laplace functions. A. BLANC-LAPIERRE. *C.R. Acad. Sci., Paris*, **232**, 934–6 (*March* 5, 1951) *In French.*

States the following theorems: if a given set of functions forms a Laplacian system, so does (*a*) a set consisting of any linear filters of these functions, (*b*) a set consisting of any finite number of increments to these functions. If, in addition, the set is stationary, a method is given for harmonic analysis. It is shown that any vibration may be resolved in a unique manner into an elliptically polarized component and a non-polarized component. N. CORCORAN

517.544.2

4995. On the harmonic analysis of stationary Laplacian random functions. A. BLANC-LAPIERRE. *C.R. Acad. Sci., Paris*, **232**, 1070–2 (*March* 12, 1951) *In French.*

Applications to the theory of polarized radiation are discussed. N. L. JOHNSON

517.6 : 530.145.6 : 539.153

4996. Electronic wave functions. III. Some theorems on integrals of antisymmetric functions of equivalent orbital form. S. F. BOYS. *Proc. Roy. Soc. A*, **206**, 489–509 (*May* 22, 1951).

A fresh formulation of the Slater methods of constructing antisymmetric functions is given. This formulation enables a systematic reduction scheme to be found for the integrals of all antisymmetric functions which occur in a completely convergent variational procedure. The theorems are purely mathematical, but the types of integral considered are those which would be obtained from functions representing both equal and different numbers of equivalent electrons. There have not previously been theorems which reduce the antisymmetry operators in the latter cases. These relations are a practical necessity for the calculations of atomic wave functions which are being reported in the present series. The theorems are equally applicable to functions which might be used for atoms, molecules, or nuclei. A.

517.9

4997. On an indeterminate differential equation occurring in an important problem in elasticity. D. S. MITRINOVITCH. *C.R. Acad. Sci., Paris*, **232**, 681–3 (*Feb.* 19, 1951) *In French.*

Solutions of the differential equation $F''/F - (f'''/f'' + f'/f)(F'/F) + n^2 f''/f = 0$, where F and f are unknown functions of x and n is an integer, are obtained in the particular case when F and f are connected by a relation of the form $F = \sigma(f')$, where σ is an arbitrary differentiable function. The equation occurs in the membrane theory of shells of revolution [C. Truesdell, *Trans Amer. Math. Soc.*, **58**, 96–166 (1945)]. The method of solution is extended to other indeterminate equations. A. T. PRICE

518.4

4998. An anistropic drafting device. L. H. BAINBRIDGE-BELL. *J. Sci. Instrum.*, **28**, 133–7 (*April*, 1951).

A drawing aid which reduces the scale of diagrams in one direction: its purpose, design and operation are described. A.

518.5

4999. Programme digital calculators (electronic calculating machines)—a general survey. III. H. RUTISHAUSER, A. SPEISER AND E. STIEFEL. *Z. angew. Math. Phys.*, **2** (*No.* 1) 1–25 (1951) *In German.*

A continuation of previous paper [part II, Abstr. 2296 (1951)]. This section deals with the preparation of a computational schedule or programme for a digital calculator. The computational plan may be illustrated by a structural diagram in which the sequential operations are represented by successive points along a continuous line; because of the facility with which this type of machine carries out repeated cyclic operations, the structural diagram often consists of several re-entrant interconnected paths, the machine itself selecting the route to be traversed on the diagram as a result of internally preset conditions. The drawing up of a structural diagram and the encoding of instructions to compel the machine to follow a required path on the diagram are discussed and illustrated by the particular example of setting a machine to multiply 2 matrices. Other topics discussed include methods of generating special mathematical functions, self-checking to detect computational errors, and automatic successive approximation to a predetermined level of accuracy.

A. SCHOFIELD

518.5

5000. The diagnosis of mistakes in programmes on the EDSAC. S. GILL. *Proc. Roy. Soc. A*, **206**, 538–54 (*May* 22, 1951).

This paper describes methods for the speedy diagnosis of mistakes in programmes for an automatic high-speed digital computer. The aim of these methods is to avoid undue wastage of machine time, and a principal feature is the provision of several standard routines which may be used in conjunction with faulty programmes to check the operation of the latter. Two of these routines are considered in detail, and the others are briefly described. A.

518.5

5001. Instrument for measuring the slope of graphs. J. F. WATERS. *J. Sci. Instrum.*, **28**, 116 (*April*, 1951).

Consists solely of a pair of pivoted arms, one of

which carries two cursors. In operation the cursor arm lies parallel to the *Y*-axis and the other arm is swivelled to lie tangentially to the graph. The slope is measured by scaling off directly on the *Y*-axis the vertical displacement corresponding to unit displacement along the *X*-axis. The use of the device has many advantages over the usual graphical method. A.

518.5 : 548.734

5002. On a new device for the summation by an optical method of Fourier series in several dimensions. G. VON ELLER. *C.R. Acad. Sci., Paris,* **232,** 1122–4 (*March* 12, 1951) *In French.*

Sine-wave patterns generated by an illuminated slit and a black-and-white mask are summed on a photographic plate. No lenses, etc., are needed. [cf. W. L. Bragg, *Z. Kristallogr.*, **70,** 475–92 (*June*, 1929)].

A. R. STOKES

518.5 : 621–52

5003. On a general treatment of problems in cybernetics. S. COLOMBO. *C.R. Acad. Sci., Paris,* **232,** 1287–8 (*March* 28, 1951) *In French.*

A brief note. Regulating devices may be reduced to 3 components: a regulator, following the independent variable and providing an output which is to be modified, a comparator-discriminator, which, acting on the signals received from the regulator, operates a servo-mechanism according to a chosen function (*F*), this mechanism changing the regulator input. *F* may be called the *intelligence* of the system. Complex systems can be developed on these lines.

A. J. KENNEDY

518.5 : 621–52

5004. Reduction of a problem in cybernetics to a problem of pursuit in Hilbert space. R. VALLÉE. *C.R. Acad. Sci., Paris,* **232,** 1288–90 (*March* 28, 1951) *In French.*

It is shown that the treatment of Colombo (preceding Abstr.) is analogous to a vector problem in Hilbert space, the operation of the system being equivalent to the convergence to zero of the distance between two points. A. J. KENNEDY

519.2

5005. On the relations between the quantity of information in Fisher's sense and in Wiener's sense. M.-P. SCHUTZENBERGER. *C.R. Acad. Sci., Paris,* **232,** 925–7 (*March* 5, 1951) *In French.*

It is shown that both definitions satisfy certain fundamental intuitive conditions of continuity, symmetry and commutativity. Generalizations of the concept are indicated. N. L. JOHNSON

519.24

5006. Simplified statistics for small numbers of observations. R. B. DEAN AND W. J. DIXON. *Analyt. Chem.*, **23,** 636–8 (*April,* 1951).

Advantages of the median as a substitute for the average are discussed. The median is especially useful when a quick decision must be made and gross errors are suspected. The range may be used to estimate the standard deviation and confidence intervals with little loss in precision for small numbers of observations. A convenient criterion for rejecting gross errors is presented. A table gives efficiencies and conversion factors for two to ten observations. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.21

5007. The electrical controls of the Bamberg 60-cm reflector. H.-U. SANDIG. *Astron. Nachr.*, **279,** 109–12 (*Jan.*, 1951) *In German.*

522.61

5008. An f : 1·0 camera for astronomical spectroscopy. A. OFFNER AND W. B. DECKER. *J. Opt. Soc. Amer.*, **41,** 169–72 (*March*, 1951).

A *f* : 1·0 spectrograph camera with a nearly flat field was designed by splitting the symmetrical ball lens of Sutton and adding correcting components. The resulting 7-element objective has longitudinal spherical aberration not exceeding 0·001 mm between 7 000 and 9 000 Å. The camera is constructed so that all adjustments of tilt and focus are made from behind the plate-holder. The plate emulsion is kept within 0·025 mm of the focal plane even when the camera is operated upside down. In astronomical use the camera photographs several hundred angstroms of spectrum at one time on flat plates, with good definition through the range 4 000 to 9 000 Å. As compared to modified Schmidt cameras, it has the disadvantage of a field limited to 7 degrees by vignetting, but is comparable in light efficiency, and has the greater convenience of allowing the use of glass plates large enough to carry multiple exposures. A.

522.61 : 523.855

5009. Photometry of extra-galactic nebulae by the Schilt method. J. BIGAY. *C.R. Acad. Sci., Paris,* **232,** 1404–6 (*April* 9, 1951) *In French.*

A continuation of work described previously [see Abstr. 3268 (1951)]. It is shown that Schilt's method of photometry may be used advantageously in the evaluation of total magnitudes of extra-galactic objects, with a mean precision of $\pm 0^{m} \cdot 2$. Systematic errors are negligibly small. D. R. BARBER

523.11 : 530.12

5010. Relativity theory and the creation of matter. W. H. MCCREA. *Proc. Roy. Soc. A,* **206,** 562–75 (*May* 22, 1951).

It is shown that the continuous creation of matter can be treated by the standard methods of general relativity provided that the possibility of a "zero-point" stress is allowed. The matter "created" is the mass-equivalent of the work done by this stress in the expansion of the universe. According to relativity theory this stress also makes a contribution to the density of gravitational mass. When these two effects are taken into account it is shown that the Newtonian analogues of relativistic models of the universe discovered by Milne and the writer can be extended to cover all relativistic models. This result makes it

possible to obtain a unified physical interpretation of Hoyle's treatment of the cosmological problem. It is suggested that the interpretation in terms of a zero-point stress may lead to a connection with the quantum theory of fields. A.

523.11 : 539.154.2

5011. On the so-called prestellar state of matter and the abundance distribution of chemical elements. I–II. G. Beskow and L. Treffenberg. *Ark. Mat. Astron. Fys.*, **34a**, *Paper* 13, 6 *pp.* (1947); *Paper* 17, 23 *pp.* (1948).

An earlier calculation of the abundances of elements from a consideration of the thermal equilibrium of a uniform distribution of matter [Abstr. 414 (1947)] is extended in Paper 13 by taking account of the excited states of nuclei; agreement with the empirical Goldschmidt curve is extended in the direction of higher mass numbers, but the discrepancies for heavy nuclei remain. In Paper 17, gravitational effects are considered, assuming that matter is concentrated into star-like configurations in which conditions for the generation of lighter and heavier elements are realized simultaneously in different layers. Calculations are made for thermal and gravitational equilibrium, at a temperature $\theta = kT \equiv 1$ MeV, for stars with close-packed cores of various radii. The relative and absolute abundances obtained are in general agreement with the observed values for the solar system, both for light and heavy nuclei. The masses of the star models considered are found to be of the same order of magnitude as for existing stars. R. A. NEWING

523.162

5012. A note on the question of interstellar absorption in the neighbourhood of the sun. H. Schmidt. *Astron. Nachr.*, **278**, 250–2 (*July*, 1950) *In German.*

A variation of absolute with apparent brightness for *B* stars whose distances can be determined by parallax is explained in terms of absorption by a narrow cloud extending from Taurus to Ophiuchus. R. A. NEWING

523.165

5013. Cosmic rays as a source of galactic radio-radiation. V. L. Ginzburg. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 3) 377–80 (1951) *In Russian.*

Discusses (*a*) general background noise, (*b*) discrete sources, and (*c*) bursts of noise in polar regions connected with aurora borealis. Given a general magnetic field of 10^{-6} gauss, (*a*) can be understood as radiation from cosmic-ray electrons, but c.r. cannot account for (*b*) by interacting with more intense stellar fields. The calculated properties for (*c*) agree with observation except for intensity which is much too low. E. P. GEORGE

523.2

5014. On the origin of the solar system. G. P. Kuiper. *Proc. Nat. Acad. Sci., Wash.*, **37**, 1–14 (*Jan.*, 1951).

A general report is given of a theory in which the formation of planetary systems is regarded as a special case of the general process of binary formation, the formation of a stellar companion or a family of planets depending on the mass distribution within the pre-planetary cloud. The segregation of planetary masses from this cloud is assumed to take place at the Roche density, at which the internal gravitational attraction within the cloud becomes equal to the tidal force of the sun, and the theory is able to predict the order of magnitude of planetary masses in terms of mean solar distances. The small angular momentum of the sun is not explained by the theory, and is regarded as part of the general problem of the slow rotation of most G-type dwarf stars. R. A. NEWING

523.36

5015. On the heat budget of the moon and the surface temperature variation during a lunar eclipse. H. Lettau. *Geofis. Pura Appl.*, **19**, 1–18 (*Jan.–March*, 1951).

During a well-defined process, as exemplified by a lunar eclipse, the local heat budget equation establishes a boundary condition at the moon surface which must be satisfied by solutions of the thermal diffusion equation in the interior. Three simplified models of the general case are discussed. A.

523.43

5016. On scattering particles in the atmosphere of Mars. E. Schatzman. *C.R. Acad. Sci., Paris*, **232**, 692–3 (*Feb.* 19, 1951) *In French.*

Agreement between the theoretical and observed variation of extinction coefficient with wavelength is obtained for particles (assumed spherical, of refractive index 1·33) of diameter about 0·15 microns. M. W. OVENDEN

523.43

5017. Determination of the atmospheric pressure on the planet Mars. A. Dollfus. *C.R. Acad. Sci., Paris*, **232**, 1066–8 (*March* 12, 1951) *In French.*

Polarimetric measurements on the disk in various spectral regions at various phases indicate an atmosphere of pressure 83 millibars. M. W. OVENDEN

523.5

5018. Meteor velocities determined by radio observations. D. W. R. McKinley. *Astrophys. J.*, **113**, 225–67 (*March*, 1951).

The phenomenological theory of radio echoes from meteors is reviewed and extended to show how meteor velocities may be computed from amplitude-time records of meteor echoes. Observational data are presented for 10 933 meteors, based on 847 hours of operation from December, 1948, to March, 1950. An empirical probability function, expressing the rates of radio meteors in terms of the zenith angle of the radiant, is deduced from the Geminid shower data. Using this function, it is shown that reasonable agreement is obtained between the observed distributions of velocities and the distributions predicted by assuming all or nearly all the meteors to be moving in elliptical orbits, more being direct than retrograde, with heliocentric velocities up to 42 km/sec. The existence of any appreciable number of interstellar meteors down to the 8th visual magnitude is doubtful. A.

523.51

5019. The theory of micro-meteorites. II. In heterothermal atmospheres. F. L. Whipple. *Proc. Nat. Acad. Sci., Wash.*, **37**, 19–30 (*Jan.*, 1951).

The theory of Pt I [Abstr. 3278 (1951)] is extended to an atmosphere of constant temperature gradient.

The validity of the assumptions in Pts I and II are examined. Numerical calculations are made on the bases of (*a*) the NCAC standard atmosphere, and (*b*) *V*-2 density measurements [Durand, "The Atmospheres of the Earth and Planets" (ed. G. F. Kuiper), Chicago (1948)]; dimensions of recovered micrometeorites tend to support densities given by (*b*). M. W. OVENDEN

523.59 : 551.593.9

5020. The zodiacal light and the outer atmosphere of the earth. V. G. FESSENKOV. *Astron. J., USSR*, **26** (*No.* 6) 344 (1949) *In Russian.* English Abstr. in *Astron. News Letter.* [*Harvard*] *No.* 54, 3 (1951).

The author's observations indicate that the light has a broad base near the horizon which may be of terrestrial origin. An asymmetry of isophotes with respect to the ecliptic is explained by assuming an extension of the earth's atmosphere in the plane of the ecliptic. [See also Abstr. 28 (1951)]. R. A. NEWING

523.6

5021. Note on the temperature of Encke's comet. E. LEBON. *Bull. Soc. Roy. Sci. Liège*, **20**, 48–59 (*Jan.*, 1951) *In French.*

The difference between the temperatures of comet Encke calculated from the theories of Minnaert [*Kgl. Ned. Akad. Wetensch.*, **50**, 826 (1947)] and Richardson [*Philos. Trans A*, **210**, 307 (1911)] is shown to be small except near perihelion. The calculated temperatures enable the order of magnitude of the heat of absorption to be estimated as within the range 5 200 to 6 000 cal/mol, the agreement of these figures with Minnaert's estimates for Halley's comet being noted. M. W. OVENDEN

523.71

5022. On the pulsation of the sun. B. MEYERMANN. *Astron. Nachr.*, **279**, 45–6 (*Sept.*, 1950) *In German.*

A re-reduction of measurements of the sun's diameter by Schur and Ambron between 1890 and 1903 indicates a pulsation of the sun of half-amplitude $0''{\cdot}09 \pm 0''{\cdot}02$ and period about 11 years, the maximum of the diameter occurring about half a year after the sunspot maximum. M. W. OVENDEN

523.72

5023. Some characteristics of 10·7-centimetre solar noise. I. A. E. COVINGTON. *J. Roy. Astron. Soc. Can.*, **45**, 15–22 (*Jan.–Feb.*, 1951).

Report on 3 years' observations (1947–49) of the solar noise, using a radio telescope of the National Research Council in Ottawa (10·7 cm wavelength). In the first instance, this analysis is concerned with the daily level of solar emission, excluding the spectacular sudden bursts. The details of the apparatus, its calibration, units of measurement and the effects of atmospheric absorption are discussed. Charts are given for the daily levels during these 3 years. The curves demonstrate a period of about 27 days in the fluctuations of the radiation which always appears to increase from a relatively constant level. A. BEER

523.72

5024. Observations of the spectrum of high-intensity solar radiation at metre wavelengths. III. Isolated bursts. J. P. WILD. *Aust. J. Sci. Res. A*, **3**, 541–57 (*Dec.*, 1950).

See Abstr. 2329 (1951) for Pt II. Observations are described of the spectrum of "isolated bursts" of solar radio-frequency radiation in the frequency range 70–130 Mc/s. These bursts last for a few seconds and have a bandwidth of the order of tens of megacycles per second. Prior observations indicate that they are not circularly polarized. They occur sporadically, often in small groups; many hours sometimes elapse between successive bursts or groups. Although, in general, their spectra show diverse features, some of them (referred to as "type III" bursts) are of a distinct type characterized by a rapid drift, with time, of the frequency of maximum intensity towards the lower frequencies, at a rate of the order of 20 Mc/s per second. Characteristics of the spectra of type III bursts are described in detail. The results are discussed and hypotheses of origin examined. It is shown in particular that the frequency drift of type III bursts cannot be attributed to the selective group retardation of waves in the solar atmosphere emanating from a fixed source. The frequency drift may, however, be associated with the rapid motion of a source travelling outwards through the solar atmosphere. A.

523.72

5025. Observations of the spectrum of high-intensity solar radiation at metre wavelengths. IV. Enhanced radiation. J. P. WILD. *Aust. J. Sci. Res. A*, **4**, 36–50 (*March*, 1951).

Observations are described of the spectrum of "enhanced radiation" from the sun (i.e. the radio-frequency radiation which maintains a high but variable level for periods of hours' or days' duration) in the frequency range 70–130 Mc/s. This radiation is known to be received from the direction of sunspots and to show circular polarization. For the purpose of presenting results, two components are recognized, viz. a background continuum which varies gradually with time and frequency, and short-lived, narrow-band bursts ("storm bursts"). The behaviour of the two components, and the relation between them during periods of high level ("noise storms") are described. A detailed analysis is given of the properties of recorded storm bursts. The distribution of recorded bursts with frequency was found to be markedly non-uniform, e.g. a pronounced minimum at 89 Mc/s was present. The possibility that the background continuum is due to the resultant of a large number of bursts is discussed. A.

523.72

5026. Radio observations of two large solar disturbances. W. N. CHRISTIANSEN, J. V. HINDMAN, A. G. LITTLE, RUBY PAYNE-SCOTT, D. E. YABSLEY AND C. W. ALLEN. *Aust. J. Sci. Res. A*, **4**, 51–61 (*March*, 1951).

On February 17 and 21–22, 1950, two exceptionally large radio-frequency disturbances of solar origin were observed on seven radio receivers working in the frequency range from 62 to 9 400 Mc/s. At each of the frequencies the r.f. power flux was recorded continuously during the disturbance and at several frequencies the polarization of the radiation was examined. The apparent position of the origin of the radiation was determined at one frequency. The time of commencement and the duration of the disturbances at the different frequencies were compared

with each other and with those of associated phenomena, solar flares, radio fade-outs, and geomagnetic effects. The two disturbances show marked similarities and marked differences; these are summarized. A.

523.72

5027. On the radiation temperature of the centre of the solar disk between 6 700 and 23 000 Å deduced from recent observations. R. PEYTURAUX. *C.R. Acad. Sci., Paris*, **232**, 1069 (*March* 12, 1951) *In French.*

A maximum temperature occurs for 16 000 Å and a minimum in the range 8 000–12 000 Å, in agreement with Chandrasekhar's calculations for absorption by H^- with an ionization potential of 0·75 eV.

M. W. OVENDEN

523.72

5028. Motion in the solar atmosphere as deduced from radio measurements. G. REBER. *Science*, **113**, 312–14 (*March* 23, 1951).

A radio disturbance associated with a solar flare gave observed times of onset which were progressively later with decreasing frequency. This disturbance is interpreted as due to turbulence in the solar atmosphere at increasing heights caused by material ejected from the flare. Estimates of velocity of the ejected material are of the same order of magnitude as velocities of the particles causing geomagnetic storms. M. W. OVENDEN

523.72 : 537.591

5029. Neutral cosmic radiation from the sun. L. BIERMANN, O. HAXEL AND A. SCHLÜTER. *Z. Naturforsch.*, **6a**, 47–8 (*Jan.*, 1951) *In German.*

It is shown that nuclear collisions of accelerated charged particles in the outer atmosphere of the sun can produce neutrons, the efficiency of the process being of the order of 1 neutron to 100 accelerated particles. It is suggested that this neutron component of cosmic radiation could be observed since the energies of the charged particles are below the cut-off energy of the earth's magnetic field. M. W. OVENDEN

523.75

5030. On the expulsion of corpuscular streams by solar flares. F. D. KAHN. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 5) 477–82 (1950).

A value is found for the minimum momentum density in a corpuscular stream which has been emitted from a flare and which causes a terrestrial magnetic storm. It is shown that radiation pressure alone will always be insufficient to expel such a stream from the sun. A.

523.75

5031. An investigation into the possibility of observing streams of corpuscles emitted by solar flares. II. F. D. KAHN. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 5) 483–90 (1950).

The ionization in a stream of solar corpuscles is re-calculated by means of two equations derived in a previous paper [Abstr. 672 (1950)]. The new values differ somewhat from those given there; in particular the Ca II content is found to be rather lower. This would make the spectroscopic detection of the stream even harder. A.

523.75

5032. An attempt to explain the polarization in Hα and D_3 for prominences. H. ZANSTRA. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 5) 491–500 (1950).

Using Heisenberg's theory as developed by Ohman for problems of this kind, it is shown that, for the line Hα, the H atom acts as a space oscillator for 35% of the incident energy, and as an isotropic scatterer for the remaining 65%. For the D_3 line of neutral He the figures are 36 and 64%. For the photospheric radiation an approximate value for the coefficient of darkening $\beta_1 = 0{\cdot}67$ is derived for the centre of Hα from Abbot's observations and Evans' residual intensities. For the D_3 line a value $\beta_1 = \beta = 1{\cdot}36$ is adopted. The theory, given for a prominence of small total optical depth, predicts for the emission a degree of polarization of 1·6% at the photosphere, and 7·5% at an altitude of 50 000 km, as compared with Lyot's observed values of 0·8 to 1·2% in general. For the D_3 emission the theory gives 2·6% at the photosphere and 8·4% at an altitude of 50 000 km, as compared with the observed 0·9 to 1·5%. The excess of the theoretical above the observational effect may in part be attributed to other processes of excitation like fluorescence and ionization and re-combination. The fact that the plane of vibration is not parallel to the solar limb, but shows deviations lying between 0° and 30° for Hα and 0° and 40° for D_3, is not explained by the simple theory. A.

523.752

5033. Observations of the solar corona outside eclipse in rays 6374·5 Å and of prominences in rays 6562·8 Å. M. N. GNEVYSHEV AND R. S. GNEVYSHEVA. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 3) 375–6 (1951) *In Russian.*

A quartz interference-polarization filter, invented by A. B. Gilvarg, of the Institute of Crystallography of the Academy of Sciences of the USSR, was added to the outside eclipse coronograph. Observations were then taken which are illustrated by photographic prints of the sun's rim, obtained on the 12th September, 1950, in 6 376·5 Å rays, 6 374·5 Å (coronal) rays and 6 562·8 Å rays. A further illustration takes the form of a prominence print taken on the 9th July, 1950, in 6 562·8 Å rays. J. CLEUGH

523.77

5034. A grating map of the solar spectrum from 3·0 to 5·2 microns. J. H. SHAW, R. M. CHAPMAN, J. N. HOWARD and M. L. OXHOLM. *Astrophys. J.*, **113**, 268–98 (*March*, 1951).

An account is given of the infrared solar spectrum from 3·0 μ to 5·2 μ obtained at the Ohio State University with a high-resolution, Pfund-type grating spectrometer of 1 meter focal length and a relative aperture of *f*/5. A Perkin–Elmer thermocouple and 13 c/s amplifier were used in the detecting system. Many features of the spectrum are discussed, and a map is presented, together with a table of wavelengths, frequencies and line identifications where possible. Among the bands and lines identified are those of H_2O, HDO, CO_2, CO, CH_4 and N_2O. A.

523.821.5

5035. Red and infrared magnitudes for 125 stars in ten areas. G. E. KRON AND J. L. SMITH. *Astrophys. J.*, **113,** 324–43 (*March*, 1951).

Magnitudes in the red and infrared spectral regions are tabulated for stars of the Polar Sequence, Harvard Standard Regions C4, C6 and C12, and Kapteyn Selected Areas 51, 57, 61, 64, 68 and 71. The methods employed for calibrating the photoelectric photometer are described in detail. An effort has been made to reduce systematic errors to a minimum. Not less than 5 stars were measured in each area. A.

523.823 : 523.85

5036. Photoelectric studies. IV. Color-luminosity array for stars in the region of the sun. O. J. EGGEN. *Astrophys. J.*, **112,** 141–77 (*July*, 1950).

For Part III see Abstr. 5449 (1951).

523.823 : 523.85

5037. Photoelectric studies. V. Magnitudes and colors of classical cepheid variable stars. O. J. EGGEN. *Astrophys. J.*, **113,** 367–412 (*March*, 1951).

523.851.3

5038. On a possible deviation of light through the Pleiades nebula. A. COLACEVICH. *Atti Accad. Naz. Lincei* (*R. C. Cl. Sci. Fis. Mat. Nat.*) **10,** 132–6 (*Feb.*, 1951) *In Italian.*

The possibility of refraction by a thin cloud of interstellar matter is indicated by a statistical analysis of radial and transverse velocity components of stars in the neighbourhood of the cluster.

R. A. NEWING

523.851.4

5039. On the determination of the velocity of a moving star cluster. J. HAAS. *Astron. Nachr.*, **279,** 136 (*Jan.*, 1951) *In German.*

Exact definition of a new method, which was first used by the author, in a simplified way, in *Astron. Nachr.*, **241,** 235 (1931), in order to determine the velocities of the members of the Ursa Major group.

A. BEER

523.852

5040. Considerations of the elements of the galactic orbits and the orientation of the circular velocity. J. HAAS. *Astron. Nachr.*, **279,** 131–6 (*Jan.*, 1951) *In German.*

The starting point is the planetary model of the galactic rotation. The elements of the orbits through a fixed point are studied as functions of the velocity; then, in a transformed coordinate-system, these curves (drawn for all orbital elements) are represented as simply as possible. The selection factors, which modify the true frequency of the elements into the apparent frequency, are discussed; it is shown that under plausible assumptions the position of the circular orbital velocity coincides with the focus of the velocity distribution. It is therefore quite legitimate, as is customary, to place the circular velocity in the velocity-centre of the stars of moderate velocities. Finally, the apparent distribution of the orbital parameters and eccentricities within 15 parsecs is derived. A. BEER

523.852.33

5041. Magellanic clouds. I. Transparency. H. SHAPLEY. *Proc. Nat. Acad. Sci., Wash.*, **37,** 133–8 (*March*, 1951).

Analysis of 385 plates taken with the 60-in Harvard reflector (scale, 1 mm = 26·6″ of arc) leads to the conclusion that the S.M.C. is essentially transparent. Both inner and outer regions show a population of faint background nebulae, approx. the same as in 8 surrounding fields. For the L.M.C. the results are very different. The axis is nearly devoid of translucent background objects, and galaxies are also scarce in both clustered and open areas of the cloud. Consequently although space absorption may be ignored at the boundary, it amounts to $c\ 1^m$ within the cloud. It is suggested that the birth of low-density, highly luminous stars may occur in the L.M.C.; whereas in the dust-free S.M.C., the age of star-birth is already past. D. R. BARBER

523.852.33

5042. Magellanic clouds. II. Supergiant red variable stars in the small cloud. H. SHAPLEY AND V. MCK. NAIL. *Proc. Nat. Acad. Sci., Wash.*, **37,** 138–45 (*March*, 1951).

Absolute magnitudes as bright as $M_{pg} = -5{\cdot}0$, and diameters > 8 astron. units are found for supergiant red variables in the S.M.C. Essentially, red variables are all members of the cloud, in common with cepheids. A survey of 14 comparison star-fields indicates the absence of typical long-period variables fainter than 14^m in lats. higher than $\pm$ 40 degrees.

D. R. BARBER

523.855

5043. Stellar populations and collisions of galaxies. L. SPITZER, JR., AND W. BAADE. *Astrophys. J.*, **113,** 413–18 (*March*, 1951).

Dense clusters of galaxies, such as the Coma and Corona clusters, contain large numbers of S0 galaxies, which are highly flattened but show no obscuration or spiral structure and presumably contain stars only of population type II. It is suggested that collisions between galaxies sweep any interstellar matter out of the galaxies in such clusters and thereby prevent the appearance of any type I systems. In the Coma cluster each galaxy will collide with at least 20 other galaxies during 3×10^9 years if the galactic motions within the cluster are largely radial. An analysis of galactic collisions shows that 2 galaxies will interpenetrate freely with relatively little effect on the velocities and positions of the stars in each galaxy, but that interstellar matter will be swept completely out of the 2 galaxies and left in intergalactic space, provided that the initial density is not much lower than $0{\cdot}1\,H$ atoms per c.c. Thus highly flattened systems, which might otherwise retain interstellar matter and develop into normal spirals, become pure type II systems. A.

523.87

5044. Spectroscopic problems of astronomical interest. P. SWINGS. *J. Opt. Soc. Amer.*, **41,** 153–65 (*March*, 1951).

The first part discusses the spectral sequence, pointing out characteristic cases of unidentified

emission or absorption lines. In the second part are indicated some of the essential needs of the astrophysicists. Except in a few rare cases reference is made to only astrophysical investigations of the last 12 years. A complete compilation of all the literature on unidentified lines or bands is not included in the present paper; but rather, typical examples have been indicated. A.

523.875

5045. Some remarks on the distribution of space velocities and kinetic energy on the Hertzsprung–Russell diagram. A. OPOLSKI. *Ark. Astron.*, **1**, *Paper* 23, 257–9 (1951).

From a study of velocity, and energy distributions for main-sequence, giant and super-giant stars, there emerge 3 limiting bolometric magnitudes which show a direct connection with Baade's population of type II stars. Limit (1), $M_{bol} = -3^{m}\cdot3$, in the region of super-giants, corresponds with position of the brightest stars of population, type II; limit (2), $M_{bol} = -0^{m}\cdot5$, coincides with the upper limit of the giant branch; and limit (3), $M_{bol} = +2^{m}\cdot4$, marks the lower limit of second branch of giants of type II on Baade's diagram. It is concluded that equipartition of k.e is very far advanced in stars represented by the following groups: (i) main-sequence stars for which $M_{bol} > +2^{m}\cdot4$; (ii) giants for which $-0^{m}\cdot1 \leqslant M_{bol} \leqslant +0^{m}\cdot6$; (iii) main-sequence stars for which $-3^{m}\cdot1 \leqslant M_{bol} < +2^{m}\cdot4$. D. R. BARBER

523.875

5046. The planets and the white dwarfs. W. H. RAMSEY. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 5) 444–54 (1950).

Russell's relationship between the planets and the white dwarfs is explained on the basis of the atomic theory of solids. A single mass-radius diagram can be constructed which refers to both the planets and the white dwarfs. The radius is an increasing function of the mass in the region of planetary masses, and it is a decreasing function of the mass for stellar masses. The radius is a maximum at some mass intermediate between planetary and stellar masses. The maximum radius depends on the chemical composition, and it is 85 000 km for H. A.

523.877

5047. On the luminosity-velocity relation of cepheids. S. ROSSELAND. *Mon. Not. Roy. Astron. Soc.*, **110**, (*No.* 5) 440–3 (1950).

The purpose of the paper is to clarify the ideas with respect to the phase relationship between luminosity and velocity of pulsating stars, which was recently discussed by Milne. Using a generalization of Milne's procedure and known results of non-adiabatic pulsation theory, it is shown that for small deviations from adiabatic equilibrium and a constant ratio of specific heats, the luminosity is closely in phase with the negative displacement, irrespective of the stellar model employed. A.

523.877

5048. Some remarks on Weizsäcker's theory of the development of giants. H.-J. BINGE. *Z. Naturforsch.*, **6a**, 49–53 (*Jan.*, 1951) *In German.*

Weizsäcker has suggested that the process of contraction that takes place when stars of large mass leave the main sequence liberates so much energy that the radiation pressure produces a very extended photosphere and allows the star to exist for a long time as a red giant. Its life-time is estimated to be of the order of 7 to 40×10^{9} years for stars of 20 to 70 solar masses. The position of the red dwarfs in open clusters and in certain kinds of double star systems is examined and it is shown that this can be best explained if one assumes that they are old stars. Furthermore, the various types of variables which occur among the red giants and intermediary dwarfs are discussed, and the analogy between both groups is emphasized. A. BEER

523.877

5049. Note on the non-radial pulsations of a homogeneous compressible sphere. E. SAUVENIER-GOFFIN. *Bull. Soc. Roy. Sci. Liège*, **20**, 20–38 (*Jan.*, 1951) *In French.*

Variations in pressure, density and potential are assumed $\propto e^{i\sigma t}$ and are expressed in terms of surface harmonics of degree n. Calculations of radial velocity and density variations throughout the sphere, and of σ^2, are made for $n = 2$, 3 and 4 for modes of oscillation of order $k = 0$, 1 and 2. Corresponding calculations are made in which perturbations in the gravitational potential are neglected, and the results are used to discuss the effect of this approximation. The error in σ is about 15% for $n = 2$, $k = 0$, but decreases as n and k increase; errors in radial velocities are negligible for stable modes. R. A. NEWING

523.877

5050. The atmospheres of the late-type stars. A. MCKELLAR. *J. Roy. Astron. Soc. Can.*, **45**, 23–35 (*Jan.–Feb.*, 1951).

523.877

5051. Exact source functions by an extension of Chandrasekhar's limiting process. V. KOURGANOFF. *Astrophys. J.*, **113**, 419–31 (*March*, 1951).

Chandrasekhar's limiting process is extended to functions describing the internal state of the atmosphere. In particular, it is shown how, by a suitable interpretation of the constants of integration, the solutions in the nth approximation for the source functions $\mathcal{J}(\tau)$ can also be transformed into a form suitable for effecting the passage to infinite approximation. Two examples of obtaining the exact $\mathcal{J}(\tau)$ by this method are given: (i) for the problem of isotropic scattering in a grey atmosphere and (ii) for a problem of line formation in a non-grey atmosphere. A.

523.877

5052. The equilibrium of the convection zone in stellar atmospheres. C. PECKER. *C.R. Acad. Sci., Paris*, **232**, 932–4 (*March* 5, 1951) *In French.*

The condition for thermodynamic equilibrium is obtained for a model atmosphere comprising a convective zone in adiabatic equilibrium below an outer radiative zone of optical depth, τ_0. The required condition is found by placing the quantity, $d/db(dB/d\tau) = 0$, where $B = (\sigma/\pi)T^4$. Values of this quantity have been computed for model atmospheres of pure H, and a mixture of H and metallic atoms, log. ratio (H/metal) = 3·8. D. R. BARBER

523.877

5053. Atmospheres possessing a convection zone in adiabatic equilibrium. C. PECKER. *C.R. Acad. Sci., Paris*, **232**, 1285–6 (*March* 28, 1951) *In French.*

A continuation of previous theoretical work on stellar atmospheres (see preceding Abstr.). The argument here is based on Chandrasekhar's second approximation. D. R. BARBER

525.35

5054. Research on selection-effects attributable to fluctuations of the rotation of the earth. F. H. VAN DEN DUNGEN, J. F. COX AND J. VAN MIEGHEM. *Bull. Acad. Roy. Belg. Cl. Sci.*, **37**, 121–5 (*Feb.*, 1951) *In French.*

Changes in clock-rate, suspected of arising from a selection-effect in the catalogued R.A.'s of transit stars, are found not to be correlated directly with a seasonal variation of the earth's rotation.

D. R. BARBER

526.1

5055. The normal section of the ellipsoid. J. M. TIENSTRA. *Bull. Géod., No.* 19, 7–21 (*March*, 1951).

Obtains (1) the formula for the angle between the normal section and the geodesic line passing through the same two points on an ellipsoid and (2) the correction if one of the points is above the ellipsoid.

A. H. COOK

526.1

5056. Principles of intrinsic geodesy. A. MARUSSI. *Bull. Géod., No.* 19, 68–76 (*March*, 1951) *In French.*

Discusses the possibility of eliminating from geodesy conventional reference surfaces which have no physical reality. It is supposed that the usual geodetic measurements of distances, angles, astronomical latitude, longitude and azimuth, of gravity and the gradient of gravity can be made and two co-ordinate systems are defined, the local astronomical (zenith, astronomical north and east) and the geodetic (using the intersection of gravitational equipotential surfaces with surfaces of constant astronomical latitude and longitude). Derivatives are obtained in tensor form and it is suggested that this development of geodesy is more suitable than that based on conventional surfaces when the lengths and directions not only of geodesic lines on the surface but also of arbitrary lines in space, have to be measured as in radar surveying. A. H. COOK

526.6

5057. On the transport of co-ordinates and azimuth along a geodesic and the inverse problem on any surface. M. MINEO. *Atti. Accad. Naz. Lincei* (*R. C. Cl. Sci. Fis. Mat. Nat.*) **10**, 142–5 (*Feb.*, 1951) *In Italian.*

Obtains series for the changes in latitude (ϕ), longitude (ω) and azimuth along a length s of a geodesic line in terms of the Lipschitz variables $p = s(d\phi/ds)_0$, $q = s(d\omega/ds)_0$ By inverting the series an expression for s in terms of the changes in ϕ and ω is developed. A. H. COOK

526.774.1

5058. The geoidal undulations and disturbing masses. L. TANNI AND E. NISKANEN. *Ann. Acad. Sci. Fennicae, Ser. AIII, No.* 24, 19 *pp.* (1951).

Examination of the geoid calculated by the aid of isostatically reduced gravity anomalies (Tanni, 1948 and 1949) shows that its remarkable undulations do not at all follow the topography. If the disturbing mass which has caused these geoid undulations is assumed to be isostatically compensated, it must be incredibly large should its compensation occur in the "crust" (Pratt) or immediately beneath the crust in the root formation (Airy). The depth of compensation being approximately inversely proportional to the disturbing mass per surface unit (Lambert's approximation), the mass is fairly moderate if the compensation of this widespread disturbing mass occurs at a great depth. A.

529.78

5059. Chronograph recording to 0·001 sec (Belin). G. MASSON. *Bull. Géod., No.* 19, 77–86 (*March*, 1951) *In French.*

A 1 000 c/s standard is divided to 50 c/s to drive a synchronous clock which provides 1 sec and 0·1 sec contacts. These operate ratchet wheels giving the number of minutes, seconds and tenths. The 0·1 sec contact also starts an electronic counter which counts from 0 to 99 msec. The timing pulse stops the counting process and the count is stored on 8 auxiliary triodes. Two wheels are rotated until the count is reached when they are automatically stopped and thus give the 0·01 sec and 0·001 sec figures. The wheels remain stationary long enough for the time to be stamped on the moving paper. Three recordings per second can be made. The apparatus is in two compartments, the main one having the dimensions 61 cm × 44 cm × 20 cm. L. ESSEN

529.786

5060. Remarks on the definition of time and the significance of the annual rate of quartz clocks. H. C. FREIESLEBEN. *Astron. Nachr.*, **297**, 128–30 (*Jan.*, 1951) *In German.*

The process by which the unit of time is derived from astronomical observations is reviewed and it is considered whether there are any residual periodic errors which would explain the annual periodic variation in the rate of quartz clocks. No final conclusion can be drawn particularly as regards the effect of aberration because most observations have in the past been made in the early evening. It is proposed to make morning observations in addition.

L. ESSEN

PHYSICS 53

53.081.6

5061. Least-squares adjusted values of the atomic constants as of December, 1950. J. W. M. DUMOND AND E. R. COHEN. Letter in *Phys. Rev.*, **82**, 555 (*May* 15, 1951).

FUNDAMENTALS 530.1

530.12

5062. Studies on five-dimensional relativity theory. C. V. JONSSON. *Ark. Fys.*, **3**, *Paper* 8, 87–129 (1951).

In the generalized 5-dimensional theory, developed

by Klein, the co-ordinate system can be chosen so that the 5 components γ_{00}, γ_{m0} of the fundamental tensor $\gamma_{\mu\nu}$ are independent of the 5th co-ordinate x^0. Rigorous field equations in such a co-ordinate system are derived, and the 5-dimensional energy-momentum tensor is calculated. The field equations obtained by linearization are examined, and it is shown that the equations then describe fields of spin $2\hbar$. The quantization of these fields is performed, and the interaction with spinor particles is taken into consideration. A.

530.12

5063. The equations of the second approximation in Einstein's new unified relativistic theory. I–II. P. UDESCHINI. *Atti Accad. Naz. Lincei* (*R. C. Cl. Sci. Fis. Mat. Nat.*) **10,** 21–4 (*Jan.*); 121–3 (*Feb.*, 1951) *In Italian.*

The tensor g_{ik} is written as $a_{ik} + b_{ik} + c_{ik}$, the 1st two terms corresponding to the 1st approx. [Abstr. 3312 (1951)], and the coefficients Γ^l_{ik} are calculated to the 2nd approx., being expressed in terms of quantities already found in the 1st approx. The results, applied to a static solution corresponding to the metric $ds^2 = (1 - 2\gamma)dx^{o2} - (1 + 2\gamma)dl^2$ of the general theory (2nd approx.), give $g_{oo} = 1 - 2\gamma + 2\gamma^2 + c^*_{oo}$, where $c^*_{oo} = c_{oo} - 2\gamma^2$ and is a solution of a Poisson equation depending on the electromagnetic field. A corresponding expression is obtained for the velocity of light. R. A. NEWING

530.12

5064. On Einstein's unified field theory. B. KURSUNOĞLU. Letter in *Phys. Rev.*, **82,** 289 (*April* 15, 1951).

Expressions for the affine field are found when the cubes of antisymmetric field variables are neglected. R. A. NEWING

530.12

5065. Unitary affine theory of the physical field. M.-A. TONNELAT. *J. Phys. Radium,* **12,** 81–8 (*Feb.*, 1951) *In French.*

Expansion of previous report, see Abstr. 826–8 (1951).

530.12

5066. Conservation laws in the general theory of relativity with electromagnetic field. H. ZATZKIS. *Phys. Rev.*, **81,** 1023–5 (*March* 15, 1951).

The principal result of this paper is the reformulation of the so-called strong conservation laws of the general theory of relativity with electromagnetic field, resulting in relationships between closed 2-dimensional surface integrals in ordinary 3-dimensional space. This formulation is particularly useful if particles are represented as singularities of the field because it obviates the necessity for an examination of the detailed structure of the singularities themselves. This method has been used for determining the total energy (or mass) in a domain containing a Schwarzschild singularity. It turns out that the value of this energy depends on the choice of co-ordinate system unless the energy density is integrated over all of space, in which case the integral converges toward the expected value. In future papers the method of closed surface integrals will be applied to the rigorous treatment of the problem of motion. A.

530.12 : 523.11

Relativity theory and the creation of matter. *See Abstr.* 5010

530.14

5067. On a theory of "conformal relativity." R. INGRAHAM. *C.R. Acad. Sci., Paris,* **232,** 938–40 (*March* 5); 1072–4 (*March* 12, 1951) *In French.*

A preliminary report of a theory, covariant with respect to the complete conformal group, in which gravitational, electromagnetic and meson fields are derived from a variational principle. R. A. NEWING

530.145

5068. The Yukawa theory of nuclear forces in the light of present quantum theory of wave fields. W. HEISENBERG. *Progr. Theor. Phys.*, **5,** 523–5 (*July–Aug.*, 1950).

An outline of a proposed solution to the problems of quantum field theory [Abstr. 835 (1951)], leading to some qualitative nuclear force considerations consistent with some theory of vector meson type, now possible in the modified theory. R. H. DALITZ

530.145

5069. Quantum mechanics. A. LANDÉ. *London, Sir Isaac Pitman and Sons* (1951) 307 *pp.*

This book lays great emphasis on the historical development of quantum mechanics and the physical problems which have led to its present form, and at every stage compares the classical with the quantum approach. It begins with chapters comparing wave and particle pictures of radiation and matter, the radiation theory which led to the old quantum theory, and the uncertainty principle, which is discussed using both wave and corpuscular theories. The usual set of problems are solved with the Schrödinger equation. In this and subsequent chapters the mathematics is as simple as possible or very abbreviated. The emphasis is on principles and methods, and on results. Matrix mechanics is introduced along the original lines of Heisenberg and is followed by the application of the time-dependent wave equation to a large number of radiation and scattering problems. Chapters on molecular spectra and quantum statistics are an innovation to textbooks on the subject. The book is completed by summaries of the consequences of the Pauli exclusion principle, of relativity and the Dirac equation, radiation and meson theory. Throughout the explicit expressions and results given and the relation of theory to experiment are valuable features. They are shown in diagrams and tables whenever possible. G. J. KYNCH

530.145 : 541.1

Quantum theory in chemistry. *See Abstr.* 5845

530.145

5070. On some developments in non-local field theory. C. BLOCH. *Progr. Theor. Phys.*, **5,** 606–13 (*July–Aug.*, 1950).

Yukawa's field equations are obtained by the variation of a Lagrangian and conservation relations of integral form discovered. Since the space-time surface defining the limits of integration cannot be chosen arbitrarily, it is concluded that infinitesimal

conservation equations do not exist. Discussion of the field-free case leads to a supplementary condition. The Lagrangian for a non-local field is given and the interaction of this with a localized electromagnetic field discussed. An analogue of the Feynman technique suitable for cases where infinitesimal transformations do not exist is suggested.

J. R. MADDOX

530.145

5071. A new interpretation of the negative energy Bose field. Y. TANIKAWA. *Progr. Theor. Phys.*, **5**, 692–5 (*July–Sept.*, 1950).

530.145

5072. On the D-function of non-local fields. Y. ÔNO AND M. SUGAWARA. Letter in *Progr. Theor. Phys.*, **5**, 902–4 (*Sept.–Oct.*, 1950).

A calculation of $[U(x), U(x')]$, where $U(x)$ is the non-local scalar field quantity introduced by Yukawa [Abstr. 3762 (1950)] leads to functions analogous to the relativistic δ-functions of localizable field theories. They elude interpretation. J. R. MADDOX

530.145

5073. Regarding covariant subtraction of infinities. G. BREIT. *Science*, **113**, 103–4 (*Jan.* 26, 1951).

It is noted that avoidance of ambiguities in field theory by definition of the singular Δ-functions as the limit of non-singular functions, symmetrical in k-space, affects only phenomena occurring in a region of space-time small relative to a certain fundamental length and has close connection with the proposals of Heisenberg [see Abstr. 835 (1951)]. R. H. DALITZ

530.145

5074. Covariant transformation law for the field equations. J. HELLER. *Phys. Rev.*, **81**, 946–8 (*March* 15, 1951).

Ordinarily, the existence of Bianchi identities is proved on the strength of the transformation properties of the Lagrangian of the theory. In this paper, nothing is assumed concerning the Lagrangian, except that the field equations themselves are covariant with respect to general coordinate transformations. It is then shown that at least the coefficients of the second-order derivatives in the field equations satisfy the usual relationships. Furthermore, a very weak restriction on the transformation law of the field equations is sufficient to derive conservation laws that hold even in the presence of matter. A.

530.145

5075. The coupling of a Dirac field to a Kemmer field. A. KLEIN. *Phys. Rev.*, **82**, 639–46 (*June* 1, 1951).

A method is given whereby a Dirac field can be so coupled to a Kemmer field as to reproduce any of the invariant coupling terms "permitted" in the usual wave formulation of meson theory. This is done independently of any statement of connection of the Kemmer wave function with the wave functions of the wave formulation. A special reducible representation of the Kemmer matrices is employed which permits the theory to be developed along lines closely analogous to the Dirac theory. As a single illustration of the utility of the theory, the nuclear forces are calculated to lowest non-vanishing order. A.

530.145

5076. On the connection between spin and statistics. W. PAULI. *Progr. Theor. Phys.*, **5**, 526–43 (*July–Aug.*, 1950).

An earlier investigation [Abstr. 35 (1941)] showed that the normal relation between spin and statistics of fundamental particles followed from 3 physically necessary postulates. This paper examines in detail the possible methods of quantization of spin 0 and spin 1 fields, leading to abnormal statistics, showing how this violates one postulate, implying use of an indefinite metric. It is verified that this latter formalism leads to 2nd-order expressions greater than unity for probability of vacuum state at $t = +\infty$, as Feynman [Abstr. 2187 (1950)] found in his own formalism. R. H. DALITZ

530.145

5077. The reversal of time and the quantization of the longitudinal field in quantum electrodynamics. K. BLEULER AND W. HEITLER. *Progr. Theor. Phys.*, **5**, 600–5 (*July–Aug.*, 1950).

For reversal of time axis, the state-vector transformation for a quantized electromagnetic field is unsymmetric between the potentials, the scalar components requiring special treatment. However, the corresponding transformation in the Gupta formalism [Abstr. 6997 (1950)] is shown to be symmetric between the 4 potentials. R. H. DALITZ

530.145

5078. On second quantization. J. G. VALATIN. *J. Phys. Radium*, **12**, 131–41 (*Feb.*, 1951) *In French.*

The antisymmetrical tensors representing the states of a system of Fermi particles are expressed in terms of the exterior algebra of Grassmann. This representation allows a natural introduction of the "creation" and "annihilation" operators of second quantization and leads to a simplification in second quantization calculations. The equivalence of operators expressed in configuration space and in second quantization may then be presented simply, the usual examination of signs being avoided. This equivalence, and the rules for calculation, are exemplified by consideration of corresponding vector equations. R. H. DALITZ

530.145

5079. Note on a Lorentz-invariant integration in the quantum field theory. Z. KOBA. *Progr. Theor. Phys.*, **5**, 696–717 (*July–Aug.*, 1950).

From the requirement that the transformation $U(\sigma, \sigma_0)$ connecting Φ on two space-like surfaces σ, σ_0 should be independent of intermediate surfaces used in definition of U, is deduced the integrability condition for the interaction Hamiltonian. It is shown generally how to construct from the Lagrangian an interaction Hamiltonian satisfying this condition. A generalization of Dyson's P-bracket notation is defined, in terms of which $U(\sigma, \sigma_0)$ may be expressed covariantly as function of the Lagrangian, whence the equivalence of the Feynman and the Tomonaga–Schwinger formalisms for the S-matrix follows directly. The theory is exemplified by calculation of the S-matrix for a Lagrangian representing an extended electron: it is noted that, with this Lagrangian, vacuum polarization is still divergent though the electron self-energy may be made finite.

R. H. DALITZ

530.145

5080. Remarks on the field theory. T. MIYAZIMA. *Progr. Theor. Phys.*, **5**, 735–9 (*July–Aug.*, 1950).

The notions of "bare" and "true" particles are discussed in relation to renormalization and vacuum polarization. It is shown that gauge invariance can be achieved by the assumption that in the distant past the charge on a particle was zero and was then switched on adiabatically. W. J. SWIATECKI

530.145

5081. On the problem of gauge-invariancy and divergence in the theory of elementary particles. I. H. UMEZAWA AND R. KAWABE. *Progr. Theor. Phys.*, **5**, 769–86 (*Sept.–Oct.*, 1950).

Two postulates redefining the vacuum and a prescription for leaving out divergent terms are proposed on the basis of a discussion of photon self-energy and vacuum polarization. They enable usually non-gauge-invariant results to be made invariant and divergencies in the self-energies of elementary particles to be reduced to lower order, in particular that of the scalar meson to be made logarithmic. A variety of examples are worked out explicitly, including questions arising in π–μ decay. W. J. SWIATECKI

530.145

5082. On gauge invariance and vacuum polarization. J. SCHWINGER. *Phys. Rev.*, **82**, 664–79 (*June* 1, 1951).

This paper is based on the elementary remark that the extraction of gauge-invariant results from a formally gauge-invariant theory is ensured if one employs methods of solution that involve only gauge-covariant quantities. We illustrate this statement in connection with the problem of vacuum polarization by a prescribed electromagnetic field. The vacuum current of a charged Dirac field, which can be expressed in terms of the Green's function of that field, implies an addition to the action integral of the electromagnetic field. Now these quantities can be related to the dynamical properties of a "particle" with space-time co-ordinates that depend upon a proper-time parameter. The proper-time equations of motion involve only electromagnetic field strengths, and provide a suitable gauge-invariant basis for treating problems. Rigorous solutions of the equations of motion can be obtained for a constant field, and for a plane wave field. A renormalization of field strength and charge, applied to the modified Lagrange function for constant fields, yields a finite, gauge-invariant result which implies non-linear properties for the electromagnetic field in the vacuum. The contribution of a zero spin charged field is also stated. After the same field strength renormalization, the modified physical quantities describing a plane wave in the vacuum reduce to just those of the Maxwell field; there are no non-linear phenomena for a single plane wave, of arbitrary strength and spectral composition. The results obtained for constant (that is, slowly varying fields), are then applied to treat the two-photon disintegration of a spin zero neutral meson arising from the polarization of the proton vacuum. We obtain approximate, gauge-invariant expressions for the effective interaction between the meson and the electromagnetic field, in which the nuclear coupling may be scalar, pseudo-scalar, or pseudo-vector in nature. The direct verification of equivalence between the pseudo-scalar and pseudo-vector interactions only requires a proper statement of the limiting processes involved. For arbitrarily varying fields, perturbation methods can be applied to the equations of motion, or one can employ an expansion in powers of the potential vector. The latter automatically yields gauge-invariant results, provided only that the proper-time integration is reserved to the last. This indicates that the significant aspect of the proper-time method is its isolation of divergences in integrals with respect to the proper-time parameter, which is independent of the co-ordinate system and of the gauge. The connection between the proper-time method and the technique of "invariant regularization" is discussed. Incidentally, the probability of actual pair creation is obtained from the imaginary part of the electromagnetic field action integral. Finally, as an application of the Green's function for a constant field, we construct the mass operator of an electron in a weak, homogeneous external field, and derive the additional spin magnetic moment of $\alpha/2\pi$ magnetons by means of a perturbation calculation in which proper-mass plays the customary role of energy. A.

530.145

5083. On the generalized transformation function and the integrability condition. K. NISHIJIMA. *Progr. Theor. Phys.*, **5**, 813–21 (*Sept.–Oct.*, 1950).

The temporal transformation operator of quantum mechanical field theory is redefined in terms of a chronology operator P^* similar to that introduced by Matthews [Abstr. 719, erratum 2186 (1950)] J. R. MADDOX

530.145

5084. Ambiguities in quantized field theories. H. FUKUDA AND T. KINOSHITA. *Progr. Theor. Phys.*, **5**, 1024–32 (*Nov.–Dec.*, 1950).

A set of conventions concerning certain improper integrals are given, sufficient to ensure that computation of infinite integrals in field theory leads to a result consistent with the requirements of gauge invariance, divergence theorem and the equivalence theorems for meson theories. R. H. DALITZ

530.145

5085. Notes on Dirac's new quantized method in the field theory. T. MUTO AND K. INOUE. *Progr. Theor. Phys.*, **5**, 1033–44 (*Nov.–Dec.*, 1950).

In the λ-limit electron theory involving negative frequency photons, as proposed by Dirac [see Abstr. 351 (1944)] it is shown that electron self-energy remains divergent in 4th order in e though vanishing in 2nd order, and that the Lamb shift is zero, contrary to experiment. R. H. DALITZ

530.145

5086. The methods of second quantization and of configuration space in the relativistic theory of systems of particles. I. Fermions without interaction. II. Spin-zero bosons without interaction. M. JEAN. *C.R. Acad. Sci., Paris*, **232**, 1183–5 (*March* 19); 1290–1 (*March* 28, 1951) *In French.*

The non-covariant method of Becker and Leibfried [see Abstr. 1229 (1946)] for deriving the configuration

space description from that of second quantization is extended to allow a covariant passage between these descriptions for both Fermi and Bose particles free from interactions. R. H. DALITZ

530.145

5087. The regularization of classical electrodynamics. H. LEHMANN. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 109–23 (1950) *In German.*

The replacement of the Green function of the Maxwell wave equation by means of regular expressions makes it possible to obtain a general derivation of various results previously obtained in this field. In this theory the self-energy of the electron is finite, and the self-stresses vanish. Field equations, advanced potentials, the energy-momentum tensor, and the radiation from an accelerated electron are discussed. It is also shown that the same conclusions may be reached if, keeping Maxwell's equations unchanged, one alters the expression of the Lorentz force. L. PINCHERLE

530.145

5088. Canonical theory of quantum electrodynamics. K. HUSIMI AND R. UTIYAMA. *Progr. Theor. Phys.*, **5**, 718–29 (*July–Sept.*, 1950).

530.145

5089. Electromagnetic induction and the principle of relativity. M. GALLI. *Atti Accad. Naz. Lincei* (*R. C. Cl. Sci. Fis. Mat. Nat.*) **9**, 343–8 (*Dec.*, 1950) *In Italian.*

Examples of e.m. phenomena which do not apparently satisfy the principle of relativity are discussed in a qualitative way, and it is shown that, of course, no contradiction arises if one bases the treatment on relativistic electrodynamics. L. PINCHERLE

530.145

5090. Heisenberg operators in quantum electrodynamics. I. F. J. DYSON. *Phys. Rev.*, **82**, 428–39 (*May* 1, 1951).

A new analytic continuation principle is described, by means of which the calculation of matrix elements of Heisenberg operators in any quantized field theory is greatly simplified. By a "Heisenberg operator" is meant an average over a finite space-time region of a field operator in the Heisenberg representation of the theory. The analytic continuation is made by varying the characteristic masses of the fields through real values. In this way a Heisenberg operator with the physically occurring masses is derived from an operator calculated with very large fictitious masses. In the region of large masses, where real creation of particles is impossible, the operator is identical with the *S*-matrix for a suitably chosen scattering problem. The calculation reduces to the calculation of an *S*-matrix, to which the techniques of Feynman are directly applicable. The *S*-matrix itself is a non-analytic function of the masses in the region of values where thresholds for real processes occur. A special device is introduced in order to by-pass the region of non-analyticity. The Heisenberg operator is modified by the insertion of real exponential damping factors which have the effect of making all energy denominators in a perturbation expansion complex. The modified operator is an analytic function of the masses and of the damping coefficients, for all real positive values of the masses. The analytic continuation is made by varying the masses while the damping coefficients are non-zero, letting the damping coefficients tend to zero when the physical values of the masses have been reached. A.

530.145

5091. Calculation of matrix elements. J. S. R. CHISHOLM. Letter in *Phys. Rev.*, **82**, 448 (*May* 1, 1951).

Various types of integrals over momentum variables, which arise in covariant electromagnetic theory, are listed together with methods employed to evaluate them. G. J. KYNCH

530.145

5092. A note on Riesz potential. F. C. AULUCK AND L. S. KOTHARI. *Proc. Camb. Phil. Soc.*, **47** (Pt 2) 436–42 (1951).

The paper discusses the Fourier expansion of the Riesz potential. For this purpose a new definition of the electromagnetic potentials, depending upon an arbitrary parameter α is given. It is shown that this definition is a generalization of the Wentzel potentials in the α-plane, whereas that given by Fremberg is a generalization of the Maxwell potentials. The analysis is applied to the problem of eliminating, in a straightforward way, the longitudinal part of the potential describing the electromagnetic field. A.

530.145

5093. On the interaction of mesons with the electromagnetic field. II. T. KINOSHITA AND Y. NAMBU. *Progr. Theor. Phys.*, **5**, 749–68 (*Sept.–Oct.*, 1950).

Completes calculation [Abstr. 77 (1951)] of 2nd-order current corrections for a meson field interacting with the electromagnetic field, using β-matrix formalism. Despite the existence of two scalars (1 and $\beta_\lambda\beta_\lambda$) in the β-algebra, it is proved generally that a true mass correction $\delta m\bar{\psi}\psi(x)$ suffices to cancel self-mass divergences, owing to a divergence relation connecting these scalars. Apart from the infra-red catastrophe, the complete correction is finite for the scalar meson, but the vector theory contains divergent quadrupole terms which cannot be renormalized. R. H. DALITZ

530.145

5094. The covariant theory of radiation damping. I. General formalism. N. FUKUDA AND T. MIYAZIMA. *Progr. Theor. Phys.*, **5**, 849–60 (*Sept.–Oct.*, 1950).

Schwinger's integral equation [Abstr. 3764 (1949)] for the invariant collision operator is solved approximately for scattering of mesons by nucleons, when the kernel is approximated by the first non-vanishing terms. Numerical results are given for the cross-section, which varies slowly with energy, but increases rapidly with the coupling constant. R. H. DALITZ

530.145

5095. Radiative corrections to decay processes. II. Beta-disintegration of nucleon. T. NAKANO, Y. WATANABE, S. HANAWA AND T. MIYAZIMA *Progr. Theor. Phys.*, **5**, 1014–23 (*Nov.–Dec.*, 1950).

Abstr. 80 (1951), part I. Continues investigations of renormalization for mixed field problems. Here, in 2nd-order radiative corrections, the high-frequency

divergences may be interpreted in terms of renormalization of the coupling constant only for certain mixtures of the usual beta-decay couplings. R. H. DALITZ

530.145

5096. Note on the infrared catastrophe. T. KINOSHITA. Letter in *Progr. Theor. Phys.*, **5**, 1045–7 (*Nov.–Dec.*, 1950).

The appearance and the cancellation of terms causing this catastrophe are discussed in terms of covariant field theory, for radiative processes. G. J. KYNCH

530.145

5097. Note on the classical equations of motion of nucleons. H. KANAZAWA. Letter in *Progr. Theor. Phys.*, **5**, 1050–2 (*Nov.–Dec.*, 1950).

The theory of Wheeler and Feynman is applied to meson fields. Apart from terms due to advanced fields the results are those of Bhabha [*Proc. Roy. Soc. A*, **172**, 384–409 (*Aug.* 23, 1939)]. The scattering of mesons by nucleons is considered. G. J. KYNCH

530.145

5098. On Yukawa's theory of non-local field. O. HARA AND H. SHIMAZU. Letter in *Progr. Theor. Phys.*, **5**, 1055–6 (*Nov.–Dec.*, 1950).

For both scalar and spinor case, Yukawa's non-local field theory [see Abstr. 3762 (1950)] is transformed into a local theory by a canonical transformation. For the case of interaction, Yukawa's *S*-matrix may be obtained from that of the local field by the same transformation. R. H. DALITZ

530.145

5099. Interactions between neutron and proton. P. SWAN. *Aust. J. Sci. Res. A.*, **3**, 519–31 (*Dec.*, 1950).

An attempt has been made to find an interaction between neutron and proton which will account for not only the binding energy and quadripole moment of the deuteron and the low energy scattering data, but also the results of the experiments on the scattering of 90 MeV neutrons by protons. Three types of modification of the triplet neutron-proton interaction have been used which embody the following features: (1) A non-central potential of spherical well form, whose radius of interaction is varied. (2) A non-central potential whose form is closer to that of the pseudo-scalar meson potential than the usual Rarita–Schwinger form, but which does not possess the objectionable singularities of the former. (3) The inclusion of a large short-range repulsion. In each case exchange forces of the usual types have been used. The results obtained, like those of other workers in this field using different forms of interaction, fail to agree with the high energy data. A.

530.145 : 539.152.1

5100. On determination of proton-proton interaction from scattering experiments. C.-E. FRÖBERG. *Ark. Fys.*, **3**, *Paper* 1–34 (1951).

A direct attempt at calculating the proton-proton interaction from available data is made. The approximation procedure developed requires the knowledge of the irregular coulomb wave function, which is tabulated (14 pp.), using an automatic computing machine. An illustration of the method gives an interaction representable by a Yukawa potential with range $1{\cdot}0$–$1{\cdot}21\times10^{-13}$ cm and strength $22{\cdot}0$–$18{\cdot}2$ MeV. Tables are given enabling new data to be conveniently used to improve the approximation. W. J. SWIATECKI

530.145 : 539.165

On radiative corrections to the angular correlation in internal pair creation. *See Abstr.* 5718

530.145

5101. Renormalization of neutral mesons in three-field problems. P. T. MATTHEWS. *Phys. Rev.*, **81**, 936–9 (*March* 15, 1951).

It is shown that a finite *S*-matrix can be obtained to low orders by renormalization if neutral spin zero mesons with (pseudo) scalar coupling are added to the mixture of nucleons, photons, and charged spin zero mesons previously considered, provided that a limited number of contact interactions are introduced. A general proof for any order is not given; but it is shown that at no stage can divergences of a new form appear, requiring the introduction of additional contact terms. Renormalization certainly fails for the pseudovector interaction and the possibility of defining a finite *S*-matrix, formally, with the use of regulators, is considered. It is shown that it is not possible to do this in a manner which is both self-consistent and consistent with the renormalization of the pseudoscalar coupling. This result is related to the "ambiguities" found in the calculation of three-field problems with the use of regulators only, and is illustrated by a detailed discussion of the two-photon decay of a neutral spin zero meson. It is concluded that cross-sections for interactions, for which renormalization is inadequate, can certainly not be calculated in this manner and that if, in fact, such theories have any meaning, it must be possible to remove the divergences in a more fundamental way. A.

530.145

5102. Lagrangian form of the theory of subtractive fields. L. DE BROGLIE. *C.R. Acad. Sci., Paris*, **232**, 1269–72 (*March* 28, 1951) *In French.*

It is shown that the Lagrangian density

$$L=\frac{1}{2}\left[\frac{1}{2}\frac{1}{k^2+k_2^2}\frac{\delta F^{\alpha\beta}}{\delta x_\gamma}\frac{\delta F^{\alpha\beta}}{\delta x_\gamma}+\frac{1}{2}F^{\alpha\beta}F^{\alpha\beta}+\frac{k_1^2k_2^2}{k_1^2+k_2^2}A^\alpha A^\alpha\right]$$

for the source-free field leads, by variation, to the field-equations previously discussed. The interaction with particles is represented by an additional term $\frac{k_2^2-k_1^2}{k_2^2+k_1^2}j^\alpha$, where j is the current-density. J. R. MADDOX

530.145 : 537.2

5103. Quantum effects in the interaction between free electrons and electromagnetic fields. C. SHULMAN. Letter in *Phys. Rev.*, **82**, 116–17 (*April* 1, 1951).

This has been detected by passing electrons through a longitudinal r.f. field, the transit time being an integral number of cycles. G. J. KYNCH

530.145

5104. The effect of electron-neutron interaction on spectral isotope shifts. L. WILETS AND L. C. BRADLEY, III. Letter in *Phys. Rev.*, **82**, 285 (*April* 15, 1951).

It is of the same order as, but less than, the isotope shift due to change in nuclear radius, and decreases faster than it for increasing Z. G. J. KYNCH

530.145

5105. Force potentials in quantum field theory. Y. NAMBU. *Progr. Theor. Phys.*, **5**, 614–33 (*July–Aug.*, 1950).

Using a Schwinger transformation, the 2nd-order interactions between spinor particles due to exchange of a boson are obtained in closed form, in terms of the operator $D = d/dt$. An ambiguity exists in the non-diagonal elements, in that these depend on the particular form of the transformation; this is resolved by discussing integrability conditions in many-time formalism. For exchange of a photon the Breit interaction is obtained by expansion of the complete potential in powers of the retardation. It is noted that this expansion is invalid for the elements connecting positive and negative frequency components of the wave-functions. Some discussion is given of 4th-order interactions, the static potentials being calculated and the non-static terms being estimated. Potentials are essentially classical unless typically quantum variables occur (Dirac spin, isotopic spin), correlations between the virtual processes producing non-classical effects. R. H. DALITZ

530.145

5106. On the method of the theory of elementary particles. M. TAKETANI, S. NAKAMURA AND M. SASAKI. *Progr. Theor. Phys.*, **5**, 730–4 (*July–Aug.*, 1950).

Difficulties of defining "elementary" particles in the presence of strong couplings are discussed. Also if, e.g., a proton is not an elementary particle its constituent particles must be sufficiently heavy to have a Compton wavelength less than the distance ($\sim 0{\cdot}3\times10^{-13}$ cm) down to which the Coulomb field is known to prevail [Abstr. 1719 (1947)]. Fermi's suggestion [Abstr. 2686 (1950)] that the π-meson is composed of strongly bound nucleons is criticized.

W. J. SWIATECKI

530.145

5107. Gauge-spin transformations and wave equations. G. IWATA. *Progr. Theor. Phys.*, **5**, 983–92 (*Nov.–Dec.*, 1950).

The tensor equations $\partial_i\phi^{ijk}\cdots=0$, $\varepsilon_{ijk}\ldots\partial^i\phi^{jk}\cdots=0$ are expressible as a single equation $\gamma^i\partial_i\phi=0$, using a suitable γ-algebra for which a faithful representation is given here. For spinor fields, invariance of this equation under spin-space transformations requires the use of another spinor field contragredient to the first. Undesirable complications result if spin transformations are required to be unitary. R. H. DALITZ

530.145

5108. The development of a theory of Marcel Riesz. The covariant form of the energy-momentum distribution function of a free electron. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **232**, 804–6 (*Feb.* 26, 1951) *In French.*

Consideration of the Fourier transforms of solutions of Dirac's equation. J. R. MADDOX

530.145

5109. A note on exchange magnetic moments. G. J. KYNCH. Letter in *Phys. Rev.*, **81**, 1060–1 (*March* 15, 1951).

Covariance under time reversal is suggested to limit the possible forms for the exchange moments. The phenomenological theory is considered using Fourier transforms. G. J. KYNCH

530.145

5110. A note on time reversal and the Dirac equation. L. BIEDENHARN. Letter in *Phys. Rev.*, **82**, 100 (*April* 1, 1951).

Wave equations with an 8×8 representation are set up the same in form as the Dirac equation. The condition that $\psi^+\psi$ is invariant under time reversal is satisfied in addition to the usual postulates of the Dirac theory. G. J. KYNCH

530.145

5111. A note on Dirac central field wave functions. M. E. ROSE. *Phys. Rev.*, **82**, 389–91 (*May* 1, 1951).

A systematic treatment is developed for the discussion of the solution of the Dirac wave equation for a central field for the purposes of theories involving the finite size of the nucleus. A.

530.145

5112. Particle spin and rotation. N. ROSEN. *Phys. Rev.*, **82**, 621–4 (*June* 1, 1951).

It is proposed to treat the spin of a particle phenomenologically by considering the particle as a small rotating sphere, the rotation of which is described by Euler parameters. If the rotation is quantized in the space of the Euler parameters, one obtains both integral and half-integral values for the spin. In this way one arrives at a formalism in which the spin components can be represented as differential operators in the Schroedinger representation. A.

530.145

5113. Meson fields and nuclear forces. L. ROSENFELD. *Progr. Theor. Phys.*, **5**, 518–22 (*July–Aug.*, 1950).

Discussion and review of the relationship between meson theories and experiments involving nuclear interactions, in the belief that the possibilities of localizable field theories are not yet exhausted. The sensitive dependence of calculated quantities on the "tail" of the meson potential, and the dearth of non-static calculations are among points emphasized.

J. R. MADDOX

530.145

5114. On the applicability of the method of the mixed fields in the theory of the elementary particles. S. SAKATA AND H. UMEZAWA. *Progr. Theor. Phys.*, **5**, 682–91 (*July–Aug.*, 1950).

A review of the realistic theory of mixed fields. The physical consequences of the C-meson hypothesis are discussed and it is noted that, though electron self-stress of mass-type vanishes in C-meson theory, divergent self-stresses related to vacuum polarization appear. Some points in the mixed field theory of vacuum polarization are also discussed. R. H. DALITZ

530.145

5115. Analysis on the two meson theory. S. NAKAMURA, H. FUKUDA, K. ONO, M. SASAKI AND M. TAKETANI. *Progr. Theor. Phys.*, **5**, 740–7 (*July–Aug.*, 1950).

An attempt to ascertain the character (scalar, vector, etc.) of π- and μ-mesons is made by a systematic

comparison of calculated (using Tomonaga–Schwinger theory) and experimental values for the lifetimes of $\pi \to e, \nu$ and $\pi \to \mu, \nu$ decays (ν = neutrino), and the capture of μ-mesons by nuclei. All types of π-mesons and interactions (scalar, vector, tensor, p.-scalar, p.-vector) are considered and the μ-meson assigned spin 0 or $\frac{1}{2}$. Divergent integrals are treated both by regularization and cut-off prescriptions. Results: (A) spin-$\frac{1}{2}$ μ-meson, (1) only for p.-scalar π-meson with p.-vector coupling is the ratio $\tau_{\pi\to\mu}/\tau_{\pi\to e}$ compatible with the experimental requirement ($\leqslant 10^{-2}$), (2) $\tau_{\pi\to\mu} \sim 10^{-8}$ sec cannot be obtained by regularotors, but several types of π-meson give the correct lifetime if an appropriate cut-off is used; (B) spin-0 μ-meson, several possibilities for the π-meson remain. W. J. SWIATECKI

530.145

5116. Production of π-mesons in nucleon-nucleon collisions near the threshold energy. H. FUKUDA AND G. TAKEDA. *Progr. Theor. Phys.*, **5**, 800–12 (*Sept.–Oct.*, 1950).

Theoretical. The calculations are carried through in a completely relativistic manner, by combining Møller's formula for collision cross-sections with the Feynman–Dyson diagrams, for calculating *S*-matrices. The results are not compared with experimental observations. E. P. GEORGE

530.145

5117. On the anomalous magnetic moment of meson. Y. ÔNO. *Progr. Theor. Phys.*, **5**, 861–9 (*Sept.–Oct.*, 1950).

Using the method of Case [Abstr. 5943 (1949)] corrections to the meson current due to interactions with the nucleon field have been evaluated to second order for all types of mesons and couplings. For scalar and ps.-scalar mesons and vector and ps.-vector couplings the corrections to the magnetic moment of the meson vanish. For vector and ps.-vector mesons they are at most a few per cent of the normal values. In these cases there appear also intrinsic quadrupole moments. For tensor and ps.-tensor couplings they are non-negligible and opposite in sign. This might be used in the future to determine the character of the π-meson. W. J. SWIATECKI

530.145

5118. Effect of nuclear binding on meson production. Y. FUJIMOTO, K. NISHINA, T. OKABAYASHI, K. TAKAYANAGI AND Y. YAMAGUCHI. *Progr. Theor. Phys.*, **5**, 870–82 (*Sept.–Oct.*, 1950).

Assuming a Fermi gas model, discusses the effect of internal motion, and the exclusion principle, on the production of mesons by X-rays and by protons, for energies of the incident particle varying from threshold to 300 MeV. The usual contradictory conclusions follow concerning the coupling constants for various types of meson field. E. P. GEORGE

530.145

5119. On the interaction of mesons and nucleons. H. ENATSU. *Progr. Theor. Phys.*, **5**, 883–93 (*Sept.–Oct.*, 1950).

The arguments of Dirac [*Proc. Roy. Soc.*, **133**, 60–72 (*Sept.* 1, 1931)] concerning a relation between magnetic and electric poles possible in a quantized theory are briefly extended here for the corresponding poles in vector meson theory. Also, 2nd-order nuclear forces are calculated for a theory in which the nucleons are coupled to a pseudovector field through both vector and pseudovector coupling. R. H. DALITZ

530.145

5120. On the negative π-meson capture. K. AIDZU, Y. FUJIMOTO, H. FUKUDA, S. HAYAKAWA, K. TAKAYANAGI, G. TAKEDA AND Y. YAMAGUCHI. *Progr. Theor. Phys.*, **5**, 931–47 (*Nov.–Dec.*, 1950).

Theoretical. Capture probabilities are evaluated for various processes for 4 different types of meson theory. On comparison with experiment it is concluded that both charged and neutral mesons are pseudo-scalar. The coupling constant cannot as yet be unambiguously assigned. E. P. GEORGE

530.145

5121. The multiple production of mesons by high energy nucleon–nucleon collisions. H. FUKUDA AND G. TAKEDA. *Progr. Theor. Phys.*, **5**, 957–76 (*Nov.–Dec.*, 1950).

Describes a perturbation method using the Tomonaga–Schwinger relativistic theory with neutral (or symmetrical), scalar (or pseudoscalar) meson theory with a coupling containing derivatives of the meson field. Comprehensive calculations of cross-sections, the multiplicity of mesons, the relative number of neutral mesons and angular distributions rule out scalar and favour pseudoscalar mesons with ps.-vector couplings. W. J. SWIATECKI

530.145

5122. Fundamental equations of the new form of meson theory. B. KWAL. Letter in *J. Phys. Radium*, **12**, 148 (*Feb.*, 1951) *In French.*

Expressions for the fields, potentials and Lagrangeans are written down for the four types of meson according to the author's new interpretation of fields [Abstr. 2382 (1951), 5257 (1949)]. W. J. SWIATECKI

530.145

5123. On the production of π-mesons in nucleon–nucleon collisions (scalar theory). J. PRENTKI. *C.R. Acad. Sci., Paris*, **232**, 1189–91 (*March* 19, 1951) *In French.*

Calculations of J. Prentki [Abstr. 3338 (1951)] (pseudo-scalar theory) applied to scalar meson theory, show that it is inferior regarding experimental agreement. W. J. SWIATECKI

530.145

5124. The binding energies of three- and four-particle nuclei. J. IRVING. *Phil. Mag.*, **42**, 338–50 (*April*, 1951).

The binding energies of the nuclei H^3, He^3 and He^4 are calculated, using the standard variation method with a simple two-parameter wave-function of a new form. Purely central interactions of the Yukawa and exponential types are considered. It is found that, when the nuclear parameters are chosen to fit the low-energy scattering and deuteron data, reasonable values are obtained for the three-particle nuclei, but the α-particle binding energy is too high. This

result is in agreement with the calculations of Rarita and Present for the exponential potential, and those of Svartholm for the Yukawa potential. In contrast with Svartholm's method of calculation, the potential and kinetic energies of the nuclei are obtained explicitly. In the case of the α-particle, the Yukawa potential yields exceptionally high values for these quantities, and results also in a very concentrated nucleus. The exponential potential, on the other hand, does not give rise to such high values for the potential and kinetic energies nor does it concentrate the nucleus to the same extent as the former potential. A.

530.145

5125. On higher Born approximations in potential scattering. R. H. DALITZ. *Proc. Roy. Soc. A*, **206**, 509–20 (*May* 22, 1951).

Many discussions of higher Born approximations are incorrect. In this paper, the second Born approximation for scattering of a Dirac electron by a Yukawa potential is calculated by a correct method. For the limiting case of the Coulomb potential, the cross-section thus obtained is just the expression obtained by McKinley and Feshbach [Abstr. 1472 (1949)] by expansion of Mott's complete solution. A corresponding calculation is sketched for the meson, using β-matrix formalism, and its physical interpretation considered. For the non-relativistic case, the behaviour of the Born series (up to third order) is discussed for the transition from Yukawa to Coulomb potential, disproving the earlier conclusions of Distel, Møller and Urban that contributions to the cross-section from higher Born approximations become infinite in this limit. A.

530.145 : 539.18

5126. The production of mesons in proton–proton collisions. J. C. GUNN, E. A. POWER AND B. F. TOUSCHEK. *Phil. Mag.*, **42**, 523–36 (*May*, 1951).

A method of estimating the cross-sections for meson production in proton–proton collisions near the threshold is outlined, together with detailed calculations for spin zero meson fields under certain simplifying assumptions concerning the nuclear forces. It is found that, for the final continuous neutron–proton system, a low energy for the neutron–proton relative motion is favoured; this, together with a large contribution from transitions to a final bound deuteron, leads to a meson spectrum well peaked at the highest allowed energies in agreement with recent experiments. While the total cross-section is dependent more on the shape and size of the inter-nucleon potential than on the meson type, the spectrum at a given angle and, more particularly, the angular distribution, are critically dependent on the parity of the produced meson. Comparison with experiment favours scalar mesons. A.

530.145

5127. Field equations, equations of motion, and wave-functions. II. A. GIÃO. *J. Phys. Radium*, **12**, 99–106 (*Feb.*, 1951) *In French.*

Abstr. 2387 (1951), part I. The authors unitary theory of matter and electricity is discussed, using the eigenfunctions of the Laplacians associated with the internal and external metrics as base vectors. This system includes solutions characterized by isotropic current vector and energy-momentum tensor of zero trace, representing elementary radiation, electromagnetic and gravitational. The quantized theory leads to de Broglie's non-singular gravitational, nuclear and electromagnetic potentials, giving finite self-energy expressions. These potentials are applied to discuss the spectrum of hydrogen. R. H. DALITZ

530.145

5128. On a formalism of the theory of particles of spin 0 or $\hbar$ and their wave equations in external fields. G. PÉTIAU. *J. Phys. Radium*, **12**, 112–22 (*Feb.*, 1951) *In French.*

The formalism discussed in detail is that where the wave-functions not directly involved in de Broglie's theory of these particles have been eliminated from the wave equations. It is compared with other formalisms. G. J. KYNCH

530.145 : 533.75

5129. The virial theorem in quantum mechanics. T. L. COTTRELL AND S. PATERSON. *Phil. Mag.*, **42**, 391–5 (*April*, 1951).

A derivation is given of a form of the virial theorem in quantum mechanics suitable for the discussion of a system of particles in a box.

530.145

5130. Properties of Dirac wave functions in a central field. M. E. ROSE AND R. R. NEWTON. *Phys. Rev.*, **82**, 470–7 (*May* 15, 1951).

The boundary conditions for a Dirac particle in a central scalar field are discussed for both bound and continuum states. In this development, the methods employed are considerably different from those customarily used for the corresponding non-relativistic case. A.

530.145.6

5131. Coulomb wave functions expressed in terms of Bessel–Clifford and Bessel functions. M. ABRAMOWITZ. *J. Math. Phys.*, **29**, 303–8 (*Jan.*, 1951).

Expressions are given for the regular solution of the equation $d^2y/dr^2 + \{1 - 2\eta/r - L(L+1)/r^2\}y = 0$, which arises in the study of the interaction of particles in a Coulomb field. Tables of the solution are being constructed for $L = 0(1)5$, 10, 11, 20, 21, $\rho = 0(0{\cdot}2)5$, $\eta = -5(1)5$; and the given expressions are useful outside the range of the tables. L. S. GODDARD

530.145.6 : 539.153 : 517.6

Electronic wave functions. III. Some theorems on integrals of antisymmetric functions of equivalent orbital form. *See Abstr.* 4996

530.162

5132. Statistical mechanics of regular mixtures. E. A. GUGGENHEIM AND M. L. MCGLASHAN. *Proc. Roy. Soc. A*, **206**, 335–53 (*May* 7, 1951).

The approximate combinatory method devised by Fowler and Guggenheim for the treatment of superlattices is here used to derive the quasi-chemical formulae for a regular mixture regarded as a system of nearly independent pairs of neighbouring sites. The method is then applied to the same mixture regarded as a system of nearly independent triplets or quadruplets of neighbouring sites on a close-packed lattice. Quantitative results for the equilibrium properties obtained by the three approximations differ from one another only very slightly. A.

530.162 : 533.7

5133. Some remarks on the condensation phenomena. S. KATSURA AND H. FUJITA. *Progr. Theor. Phys.*, **5**, 997–1009 (*Nov.–Dec.*, 1950).

It is shown that isothermal compression of gas produces another phase, and further compression converts the gas to liquid. By consideration of a microcanonical ensemble, it is shown that the plot of number of cells *v*. the number of molecules in each cell has for certain volumes two sharp maxima. To obtain the behaviour of the partition function, a Lennard–Jones interaction is assumed for a model whose free energy is calculated using hole theory.

G. J. KYNCH

530.162 : 536.75

The communal entropy of dense systems. *See Abstr.* 5374

530.162 : 537.12

A collective description of electron interactions. *See Abstr.* 5379

530.162 : 539.11

5134. A theory of cooperative phenomena. R. KIKUCHI. *Phys. Rev.*, **81**, 988–1003 (*March* 15, 1951).

A new method of approximation for order-disorder phenomena is developed. The method is explained for the 1-dimensional Ising lattice, and the approximations already known are covered, such as those of Bethe and of Kramers–Wannier, which are shown to be derived as special cases of the method with suitable choices of variables. An improved treatment is explained for the 3-dimensional simple cubic Ising lattice. This approximation is found to agree with the rigorous expansion of the partition function up to the fourth moment by Kirkwood's moment method, so far as the disorder state is concerned. The general formula for the entropy is given, and an improved treatment of the face-centred lattice (Ising model) is given. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.23

5135. Suspension strip. P. CHRISTOPH. *Arch. Tech. Messen, Issue No.* 182 (*Ref. J*013–5) T34 (*March*, 1951) *In German.*

Suspensions for comparatively heavy weights (e.g. gyros, torsion balances, torsional pendulums for clocks) are considered. Formulae are given for: (1) torsion moment for given dimensions of suspension, suspended weight, torsion angle, and constants of suspension material; (2) width/thickness ratio of suspension to give minimum torsion moment for given cross-sectional area; (3) ratio of torsion moments of round wire and rectangular suspension of optimum width/thickness ratio, of same cross-sectional area and material; (4) time of swing as function of weight and amplitude. C. F. PIZZEY

531.259.1

5136. Note on a penny-shaped crack under shear. C. M. SEGEDIN. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 396–400 (1951).

531.55

5137. On the accuracy of the long-range ballistic rocket. W. E. FRYE. *J. Appl. Phys.*, **22**, 585–9 (*May*, 1950).

The accuracy of a V-2 type ballistic rocket which is guided to the termination of propulsion and is in free flight thereafter is investigated. The effect of the rotation of the earth and the re-entry into the atmosphere on the accuracy is considered and the errors due to lack of thrust control are analysed. A.

531.57

5138. Penetration by high-velocity ("Munroe") jets. I. D. C. PACK AND W. M. EVANS. *Proc. Phys. Soc., Lond. B*, **64**, 298–302 (*April*, 1951).

By means of certain simplifying assumptions a formula is developed for the penetration into a ductile target by a high-velocity jet. The action is divided into two stages, each making its contribution to the total penetration. First, a hole is formed by the lateral compression of the target as the jet penetrates it; the second stage begins when the last particle of the jet has ceased to act, the hole continuing to deepen until the residual energy in the target has been spent. At the high pressures set up the strength of the target plays only a subsidiary part in the phenomenon. A.

531.57

5139. Penetration by high-velocity ("Munroe"(jets. II. W. M. EVANS AND D. C. PACK. *Proc. Phys. Soc., Lond. B*, **64**, 303–10 (*April*, 1951).

The two stages of penetration were separated experimentally. The large penetrations measured in lead targets are shown to result from the flow which takes place in the metal after the jet itself has been consumed. For a given jet at a given stand-off it is possible to predict the penetration into a combination of targets from the results of a very small number of standard experiments. The method depends upon the calculation of a certain quantity which is constant for a given jet at a given stand-off, and examples are given of the determination of this quantity from experimental data. A.

MECHANICAL MEASUREMENTS 531.7

531.717.1 : 539.23 : 539.16.08

5140. Determination of thickness of a thin film obtained by condensation of artificial radioactive elements. M. DEVIENNE. *C.R. Acad. Sci., Paris*, **232**, 1088–9 (*March* 12, 1951) *In French.*

A method of measuring the thickness of films of radioactive Sb is described. The films were obtained by condensation from molecular beams on to a plate, precautions being taken to ensure a uniform deposit. The activity of the film is measured and compared with that of standards deposited on identical surfaces. These standards were prepared by evaporating a drop of a solution of $SbCl_3$ obtained by the action of *aqua regia* on a known mass of radioactive Sb. The plate was covered with a very thin film of paraffin to ensure that the liquid spread uniformly over the plate. A. J. MEE

531.787

5141. A null method mercury cistern manometer. K. R. Honick. *J. Sci. Instrum.*, **28**, 140–2 (*May*, 1951).

The instrument is suitable for the measurement of pressures over the range ±1 atm. to within 0·01 in. The null method eliminates the need for contracted scales and consistency of bore, and dismantling, cleaning and replacement of components can be performed without recalibration. Only one short length of glass tubing is used in the construction and the instrument is readily transportable. An advantage is that the manometer is always observed at the same fiducial point. A.

MECHANICS OF FLUIDS 532

532.13

5142. Viscosities of liquids at constant volume. A. Jobling and A. S. C. Lawrence. *Proc. Roy. Soc. A*, **206**, 257–74 (*April* 10, 1951).

The design and construction of a falling-cylinder viscometer for use at pressures up to 3 000 atm. are described. The instrument has been employed for the first direct measurement of the variation of the viscosity of a liquid with temperature at a constant volume which is determined by the density of the liquid at the temperature at which the high-pressure vessel is filled and sealed. Preliminary measurements are reported on benzene and carbon tetrachloride. The results have confirmed experimentally the straight-line relation between $\log \eta$ and $1/T$ at constant volume as predicted in the viscosity theories of Andrade and of Eyring, Glasstone and Laidler. $\mathscr{E}_v$, the energy of activation of viscous flow at constant volume, has been calculated over a wide volume range and its importance is discussed. For many simple organic liquids, there appears to be a simple general relation between $\mathscr{E}_v$ and volume. $\mathscr{E}_v$ is considered to be the "true" activation energy of viscous flow and its relation to E_{vis}, the quantity usually described as the activation energy of viscous flow, calculated from the variation of the viscosity with temperature at constant (atmospheric) pressure, is discussed. A.

532.137 : 621.317.39

5143. Capacitance-change viscometer. R. W. Thickens. *Electronics*, **24**, 116–17 (*April*, 1951).

A modified reversed Wagner-type cup-and-ball viscometer is employed in conjunction with an electrical timer which measures the interval between instants when the cup-fluid-ball separation is 0·005 and 0·003 in, the fluids under investigation being dielectrics. The cup-fluid-ball combination forms part of the tuning capacitance of a variable-frequency Hartley oscillator. This oscillator feeds two channels, each tuned to one of the two frequencies corresponding to the a/m spacings. The rectified outputs of the channels each charge a capacitor across the grid circuits of an Eccles–Jordan pair, in the anode circuits of which are relays controlling a 60 sec and a 6 000 sec clock. Thus resonance in one channel, corresponding to the 0·005 in spacing, starts the clocks and subsequently resonance in the other, corresponding to the 0·003 in spacing, stops them. Reproducibility within 1% is claimed.

H. G. M. SPRATT (R)

532.517.3

5144. Secondary circulation in fluid flow. W. R. Hawthorne. *Proc. Roy. Soc. A*, **206**, 374–86 (*May* 7, 1951).

Secondary circulation appears after fluid with a non-uniform velocity distribution passes round a bend. It alters the character of the flow and is a source of loss. A general expression is developed for its change along a streamline in a perfect, incompressible fluid. The flow in bent circular pipes is analysed and the theory is compared with experiments on bent pipes and rectangular ducts. In bends the secondary flow is not spiral but oscillatory, the direction of the circulation changing periodically. The theory shows that secondary circulation remains unchanged if streamlines are geodesics on surfaces of constant total pressure. A.

532.517.4

5145. Similarity and self-preservation in isotropic turbulence. R. W. Stewart and A. A. Townsend. *Philos. Trans A*, **243** (*No.* 867) 359–86 (1951).

Measurements of the double and triple velocity correlation functions and of the energy spectrum function have been made in the uniform mean flow behind turbulence-producing grids of several shapes at mesh Reynolds numbers between 2 000 and 100 000. These results have been used to assess the validity of the various theories which postulate greater or less degrees of similarity or self-preservation between decaying fields of isotropic turbulence. It is shown that the conditions for the existence of the local similarity considered by Kolmogoroff and others are only fulfilled for extremely small eddies at ordinary Reynolds numbers, and that the inertial subrange in which the spectrum function varies as $k^{-\frac{5}{3}}$ (k = wave-number) is non-existent under laboratory conditions. Within the range of local similarity, the spectrum function is best represented by an empirical function such as $k^{-a \log k}$, and it is concluded that all suggested forms for the inertial transfer term in the spectrum equation are in error. Similarity of the large-scale structure of flows of differing Reynolds numbers at corresponding times of decay has been confirmed, and approximate measurements of the Loitsianski invariant in the initial period have been made. Its value, expressed non-dimensionally, decreases slowly with grid Reynolds number within the range of observation. Turbulence-producing grids of widely different shapes are found to produce flows identical in energy decay and in structure of the smaller eddies. The largest eddies depend markedly on the grid shape and are, in general, significantly anisotropic. Within the initial period of decay, the greater part of the energy spectrum function is self-preserving, and this part has a shape independent of the shape of the turbulence-producing grid. The part that is not self-preserving contains at least one-third of the total energy, and it is concluded that theories postulating quasi-equilibrium during decay must be considered with great caution. A.

532.517.4

5146. Pressure fluctuations in isotropic turbulence. G. K. BATCHELOR. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 359–74 (1951).

This paper considers the correlation $P(r)$ between the fluctuating pressures at two different points distance r apart in a field of homogeneous isotropic turbulence. $P(r)$ can be expressed in terms of the fourth moment of the velocity fluctuation, which is evaluated with the aid of the hypothesis that fourth moments are related to second moments in the same way as for a normal joint distribution of the velocities at any two points. The experimental evidence relevant to this hypothesis (which cannot be exactly true since it gives zero odd-order moments) is examined. The alternative hypothesis made by Heisenberg, that the Fourier coefficients of the velocity distribution are statistically independent, has identical consequences for the fourth moments of the velocity, although it does not lead to such convenient results. The pressure correlation is worked out in detail for the important special case of very large Reynolds numbers of turbulence; the mean-square pressure fluctuation is found to be $0{\cdot}34\rho^2(\overline{u^2})^2$. The mean-square pressure gradient is evaluated, from the available data concerning the double-velocity correlation, for the cases of very small and very large Reynolds numbers, and a simple interpolation between these results is suggested for the general case. Finally, the relation between the mean-square pressure gradient and rate of diffusion of marked fluid particles from a fixed source is established without the neglect of the viscosity effect, and the available observations of diffusion are used to obtain estimates of $\overline{(\nabla p)^2}$ which are compared with the theoretical values. A.

532.517.4

5147. The structure of the turbulent boundary layer. A. A. TOWNSEND. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 375–95 (1951).

The nature of the turbulent motion in a boundary layer with zero longitudinal pressure gradient has been investigated using the techniques of hot-wire anemometry which have been developed for the study of shear flow in wakes. Measurements have been made of the intensities of the turbulent velocity components, the turbulent shear stresses, the rates of transport of turbulent energy by diffusive movements, the intensities and flattening factors of the down-stream spatial derivatives of the three velocity components, and spectra of the down-stream component of the velocity fluctuation, at traverses through the boundary layer at three stations where the Reynolds numbers (based on the displacement thickness and free stream velocity) were respectively 3 630, 4 360 and 5 080. Over the range of measurement, which did not include the laminar sublayer, the turbulent motion was similar at all three stations, and could be described in terms of universal functions. By considering the turbulent energy balance, it is shown that, except in the outer part of the layer where the turbulence resembles strongly the turbulence in a wake, there is a strong flow of energy directed toward the wall and transported by the action of turbulent pressure gradients. It is concluded that, most probably in contact with the laminar sublayer, there must be a "dissipative layer" within which most of the turbulent energy dissipation takes place, and that the bulk of the eddies are, in a sense, attached to the wall and have very high rates of shear in that region. In agreement with this view of the structure of the turbulence, length scales derived from the apparent eddy viscosity and the local turbulent intensity are found to be comparable with distance from the wall. Length scales in the direction of the mean stream are much larger, and it is believed that the typical eddy is very elongated in this direction, and has its vorticity directly roughly parallel to the direction of maximum positive mean rate of strain. A.

532.517.4

5148. Numerical results for pressure-velocity correlations in homogeneous isotropic turbulence. D. N. LIMBER. *Proc. Nat. Acad. Sci., Wash.*, **37**, 230–3 (*April*, 1951).

532.528

5149. Some effects of cavitation near 30 cps. W. H. PIELEMEIER. *J. Acoust. Soc. Amer.*, **23**, 224–8 (*March*, 1951).

Publications by other investigators on the production of cavitation in liquids and its effects are discussed. Several points in favour of l.f. cavitation studies are listed. Two methods were used by the author to feed power at about 30 c/s into the liquids. In one method a thick-walled Lucite tube containing the liquid was attached to the vibrating element of a Sonntag Universal Fatigue Machine. Similar results were obtained with a modified paint spraying compressor which had a vibrating diaphragm instead of a metal piston. Photographs show both methods. Emulsions and suspensions were made in a few minutes, the cleansing effect on cloth soiled in a standard manner was tested and the oxide coating on Al foil was removed. Probably greater corrosive effects could be obtained with the same power at higher frequencies. A.

532.593

5150. Trapping modes in the theory of surface waves. F. URSELL. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 347–58 (1951).

It is shown that a mass of fluid bounded by fixed surfaces and by a free surface of infinite extent may be capable of vibrating under gravity in a mode (called a trapping mode) containing finite total energy. Trapping modes appear to be peculiar to the theory of surface waves; it is known that there are no trapping modes in the theory of sound. Two trapping modes are constructed: (1) a mode on a sloping beach in a semi-infinite canal of finite width, (2) a mode near a submerged circular cylinder in an infinite canal of finite width. The existence of trapping modes shows that in general a radiation condition for the waves at infinity is insufficient for uniqueness. A.

532.593

5151. Total reflection of surface waves by deep water. J. D. ISAACS, E. A. WILLIAMS AND C. ECKART. *Trans Amer. Geophys. Un.*, **32**, 37–40 (*Feb.*, 1951).

A mechanism is described by which surface gravity waves generated in shallow water may be totally

reflected from deep water. The mechanism by which waves generated in deep water may be "captured" is also discussed. A.

532.593

5152. An experimental study of the pressure variations in standing water waves. R. I. B. Cooper and M. S. Longuet-Higgins. *Proc. Roy. Soc. A*, **206**, 424–35 (*May* 7, 1951).

Although the first-order pressure variations in surface waves on water are known to decrease exponentially downwards, it has recently been shown theoretically that in a standing wave there should be some second-order terms which are unattenuated with depth. The present paper describes experiments which verify the existence of pressure variations of this type in waves of period 0·45 to 0·50 sec. When the motion consists of two progressive waves of equal wavelength travelling in opposite directions, the amplitude of the unattenuated pressure variations is found to be proportional to the product of the wave amplitudes. This property is used to determine the coefficient of reflection from a sloping plane barrier. A.

CAPILLARITY 532.6

532.612.4 : 532.7

5153. The determination of diffusion coefficients by measurements of surface tension. E. R. Washburn and H. N. Dunning. *J. Amer. Chem. Soc.*, **73**, 1311–13 (*March*, 1951).

A new experimental method for the determination of diffusion coefficients has been developed. The process of diffusion of a surface active solute through a liquid in a calibrated capillary is followed by measurements of surface tension. The diffusion coefficient may be calculated by either an application of Fick's second law or an application of a heat conduction equation of Ingersoll and Zobel. The value of the diffusion coefficient for normal butyl alcohol in water as determined by this method is of the same order of magnitude as the values recorded in the literature. A.

532.613 : 541.135

5154. A wedge effect at amalgam/electrolyte surfaces. R. J. Johnston and A. R. Ubbelohde. *Proc. Roy. Soc. A*, **206**, 275–86 (*April* 10, 1951).

When amalgams are formed by discharge of the ions Li^+, Na^+, K^+, Ca^{++}, Mg^{++} NH_4^+, at a Hg cathode in a glass vessel, a wedge of electrolyte penetrates between the amalgam and the glass. The effect is not observed for the discharge of Ag^+, Zn^{++}, Cd^{++} or OH_3^+ ions. To elucidate the origin of the forces maintaining the wedge in equilibrium, the wedge thickness and the curvature of the Hg/electrolyte interface have been investigated in various ways. The apex of the wedge was studied by interferometry. Measurements have been made during electrolysis of the interfacial tensions Hg/electrolyte and Hg/gaseous nitrogen. Possible theoretical interpretations are discussed. A marked reduction of the surface tension which is observed at certain amalgam/electrolyte interfaces is attributed to strong surface adsorption of the metal especially when the atom is more readily polarized than Hg. The electro-positive character of the amalgams and this reduction of surface tension explain some of the phenomena of the wedge effect. A.

532.65

5155. Surface tension of small droplets as a function of size from critical supersaturation data. G. M. Pound and V. K. LaMer. Letter in *J. Chem. Phys.*, **19**, 506 (*April*, 1951).

The surface tension of water droplets has been calculated from published critical supersaturation data and the results plotted against (*a*) temperature (over the range 280°K–220°K), (*b*) number of molecules per stable nucleus, and (*c*) nucleus diameter. As the temperature and size fall the surface tension of the droplets appears to pass through a maximum.

J. IBALL

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 530.162

5156. Cluster integrals and the Thiele semi-invariants. S. Ono. Letter in *J. Chem. Phys.*, **19**, 504–5 (*April*, 1951).

By using some results of statistical theory the theory of liquids due to Mayer has been simplified.

G. J. KYNCH

532.7 : 539.132

5157. Several consequences of the notion of swarms in liquids. J. Winter. *C.R. Acad. Sci., Paris*, **232**, 1076–8 (*March* 12, 1951) *In French.*

A consideration of the effect on hydrodynamics, biology, chemistry, etc., of the conception of molecular groupings or swarms in liquids. This conception of swarms, or cybotactic regions, has already been made use of [see Abstr. 1454 and 2743 (1948)].

T. C. TOYE

532.712.082

5158. The theory of measurement of osmotic pressure. A. J. Staverman. *Rec. Trav. Chim. Pays-Bas*, **70**, 344–52 (*April*, 1951).

Application of Onsager's symmetry relations to the process of diffusion of a solution through a membrane shows that measured osmotic pressures deviate from those calculated thermodynamically in proportion to the permeability of the membrane to the solute molecules. Therefore little is learned from one dynamic osmotic measurement, but by simultaneous measurements of osmotic pressure and permeation at different membranes the entire molecular weight distribution of the solute can be computed. A.

532.72

5159. Aqueous diffusion measurements by the Lamm scale method and their correlation with membrane diffusion measurements. D. G. Gillam. *Aust. J. Sci. Res. A*, **4**, 84–92 (*March*, 1951).

The diffusion of KCl, NaCl, K_2SO_4 and sucrose in water is investigated by means of a simplified form of the Lamm scale method. The maximum

height method of calculation is modified in such a way that the experimental procedure is less laborious. The diffusion coefficient values are obtained over a range of temperatures and the activation energies for free diffusion calculated. Comparisons are made with the predictions of the Debye–Hückel–Onsager theory and with the results of membrane diffusion measurements. The defects of the method are discussed and a more refined method is described by which it should be possible to calculate the concentration-dependence of the diffusion coefficient and also the influence of solvent counterflow. A.

532.72 : 539.16

5160. Self-diffusion and structure of liquid water. I. Measurement of self-diffusion of liquid water with deuterium as tracer. J. H. WANG. *J. Amer. Chem. Soc.*, **73**, 510–13 (*Feb.*, 1951).

A method for measuring self-diffusion of liquids by means of capillaries is described; the accuracy of the present method is within about 1%. The self-diffusion coefficients of liquid water in the temperature range 0 to 55° have been determined by both the capillary method and the usual diaphragm-cell method with D as tracer. Data of the present work support the quasi-crystalline structure of liquid water and are in contradiction with the assumed existence of definite species of associated water molecules in liquid water. The average apparent activation energy, 4·58 kcal/mole, for self-diffusion of liquid water in the temperature range 10 to 50° indicates that water in this temperature range is only very slightly more than two-co-ordinated. Below 5°, however, the apparent activation energy of self-diffusion increases appreciably as temperature drops, reaching the approximate value of 6·4 kcal/mole at 0°. A.

532.73 : 541.64

5161. On the theory of the high polymer solution. H. ICHIMURA. Letter in *J. Chem. Phys.*, **19**, 516–7 (*April*, 1951)

An attempt to show how the interaction between the polymer segments and the solvent should be accounted for in the theory of high polymer solution with special reference to dilute solutions of flexible linear high polymers. T. C. TOYE

532.73–1 : 532.13

5162. Relation between gas evolution and physical properties of liquids. V. G. SZEBEHELY. *J. Appl. Phys.*, **22**, 627–8 (*May*, 1951).

Four heavy lubricating oils, three light lubricating oils, and three aircraft engine fuels were tested for viscosity, surface tension, and density, and a relation was established between the time rate of evolution and solution of air and the viscosity of the liquids. A definite relation was also found between solubility constants and half-lives as well as between half-lives of evolution and solution. A.

532.77 : 541.64

5163. The concentration dependence of the viscosity of solutions of macromolecules. J. RISEMAN AND R. ULLMAN. *J. Chem. Phys.*, **19**, 578–84 (*May*, 1951).

The theory is developed for the dumbbell, rigid rod, and flexible chain macromolecules. Both the intramolecular hydrodynamic interactions between the monomer units of the same molecule and the intermolecular interactions between monomer units of different molecules are considered. The methods of Riseman and Kirkwood are applied throughout. The numerical result of the calculation for the dumbbell shaped molecule is compared with that obtained by Simha. A.

MECHANICS OF GASES 533

533.15

5164. Thermal diffusion in hydrogen–water vapor mixtures. E. WHALLEY. Letter in *J. Chem. Phys.*, **19**, 509–10 (*April*, 1951).

Values of R_T are recalculated from data of Shibata and Kitagawa [*J. Fac. Sci. Hokkaido Univ.*, **2**, 223 (1938)]. R. H. DAVIES

533.15

5165. An interferometric method of determining diffusion coefficients in gaseous systems. C. A. BOYD, N. STEIN, V. STEINGRIMSSON AND W. F. RUMPEL. *J. Chem. Phys.*, **19**, 548–53 (*May*, 1951).

The change of composition in the diffusion cell is followed by measuring the change in refractive index with an interferometer. Results obtained using this method compare favourably with some values reported in the earlier literature. In addition, values are reported for new systems not studied previously. A comparison is made between measured values and those calculated from viscosity data. A.

533.15

5166. Diffusivity of water vapor in some common gases. F. A. SCHWERTZ AND J. E. BROW. *J. Chem. Phys.*, **19**, 640–6 (*May*, 1951).

From the measured rates of diffusion of water vapour into pure H, He, CH_4, C_2H_4, N_2, O_2, and CO_2, the mutual coefficients of diffusion have been determined. Measurements were made at 34°, 56°, and 80°C and at atmospheric pressure employing the technique of Stefan. A.

533.6 : 532.593

5167. The aerodynamic drag of a free water surface. J. R. D. FRANCIS. *Proc. Roy. Soc. A*, **206**, 387–406 (*May* 7, 1951).

The drag exerted by wind on a water surface has been measured in a tunnel 7·5 cm wide and 7 m long in which winds up to 14 m/sec can be made. The waves thus formed are similar to those seen at sea. A device increases the effective fetch and therefore the size of the waves. The drag is measured by the slope of the mean water surface. The shear-stress coefficient $\gamma_a^2 = \tau/\rho u_a^2$ increases nearly linearly with wind speed, and the drag therefore increases nearly with the cube of the speed. There is a not unsatisfactory agreement with field results of shear coefficient, when the wind velocity is extrapolated to the greater height at which it is usually measured over the sea. It is thought that this agreement between the drag of small laboratory

waves and large field waves may show that the mechanism for drag is not controlled by the wave size or speed, but perhaps by the tiny wind ripples. The variation of wind speed with height has been measured. The profiles sometimes show anomalies in the zone up to about 8 cm above the crests, there being slow layers of air between faster ones. The height of the anomalous zone increases as the waves become higher. Above 8 cm the usual rough boundary law holds good. An empirical law is given for the shear stress as a function of the speed of the surface layer of water. A.

533.6.011

5168. Steady, plane, rotational Prandtl–Meyer flow of a polytropic gas. M. H. MARTIN. *J. Math. Phys.*, **29,** 263–81 (*Jan.*, 1951).

Isoenergetic, anisentropic Prandtl–Meyer flows of a polytropic gas are investigated, a Prandtl–Meyer flow being defined as a flow in the physical plane the hodograph of which is a single arc in the hodograph plane. Many characteristics of isentropic flows are not shared by anisentropic flows. Thus, in isentropic flows, the isobars ($p = \text{const.}$) and isopyenics ($\rho = \text{const.}$) coincide. It is shown that this is not necessarily the case for anisentropic flows. In isoenergetic, isentropic flow, the density, ρ, remains within finite limits, but a finite density cannot always be anticipated over a field of isoenergetic, anisentropic flow; this result is confirmed by examples. In classical Prandtl–Meyer corner flow of a polytropic gas the hodograph of the flow is an arc of an epicycloid; in isoenergetic, anisentropic flow the place of the epicycloid in the hodograph plane is taken by a family of roulettes, depending on a certain parameter. The isobels ($q = \text{const.}$) are straight lines for a large class of general Prandtl–Meyer flows. Forms of the stream lines, isobars and isopyenics are examined in considerable detail, the analysis being based upon the determination of solutions of a quasi-linear differential equation [Abstr. 886 (1951)]. J. S. G. THOMAS

533.6.011

5169. Behaviour of various gases and separation of mixtures of gases in a vortex tube. K. ELSER AND M. HOCH. *Z. Naturforsch.*, **6a,** 25–31 (*Jan.*, 1951) *In German.*

The experiments with vortex tubes are reviewed. The assumption that kinetic gas phenomena are playing a decisive role in these tubes is supported by (1) measurements of the temperature effect obtained when using various gases, (2) occurrence of similar phenomena in gas flows of another kind, and particularly by (3) demonstration that mixtures of gases undergo a partial separation in the vortex tube. F. LACHMAN

533.6.011.4

5170. Several considerations of transonic slip. D. RIABOUCHINSKY. *C.R. Acad. Sci., Paris,* **232,** 1047–9 (*March* 12, 1951) *In French.*

The theory of slipping applied to subsonic, sonic and supersonic motion is extended to the particular case of transonic speeds using Reynolds' approximation. T. C. TOYE

MOLECULAR THEORY OF GASES 533.7

533.7

5171. On the viscosity of gaseous He^3. O. HALPERN. Letter in *Phys. Rev.*, **82,** 561 (*May*, 1951).

533.75

5172. Corresponding states in mixtures of slightly imperfect gases. E. A. GUGGENHEIM AND M. L. MCGLASHAN. *Proc. Roy. Soc. A,* **206,** 448–63 (*May* 22, 1951).

The principle of corresponding states, in a form that makes no reference to any particular equation, is extended to apply to mixtures. The principle, thus extended, is used to calculate the second virial coefficients of gaseous mixtures. The values so calculated agree with the experimental values nearly always to within 1 cm^3/mole and often much better. A.

VIBRATIONS . ACOUSTICS 534

534.113

5173. The position of the nodes of the transverse vibrations of a uniform thin fixed-free bar. R. HELLER. Letter in *J. Acoust. Soc. Amer.*, **23,** 232 (*March*, 1951).

534.121.1 : 548.0 : 537.228.1 : 539.32

5174. Contour modes of square plates excited piezoelectrically and determination of elastic and piezoelectric coefficients. R. BECHMANN. *Proc. Phys. Soc., Lond. B,* **64,** 323–37 (*April*, 1951).

The suitability of square plates, vibrating in contour modes, for the determination of piezoelectric coefficients is considered. Piezoelectric measurements on such plates provide checks for the theoretical solution of the various modes and in particular for the distribution of displacement. The recently published solutions for square plates form a basis for this work and the reliability of these solutions is discussed. The materials used were sodium chlorate, sodium bromate, quartz, ammonium dihydrogen phosphate and ethylene diamine tartrate (EDT). New determinations of the elastic and piezoelectric coefficients of these materials have been made, with the exception of EDT, the data for which were published in a previous paper [Abstr. 8322 (1950)]. A.

534.13

5175. On multiple excitation of an elastic system. G. S. BENNETT. *J. Acoust. Soc. Amer.*, **23,** 229–31 (*March*, 1951).

The possibility of excitation of nonlinear elastic system by the combination frequencies produced when two forces of different frequencies act on the system is investigated, using the approximate method of Rayleigh. Experimental evidence is cited to support the results of the calculations, namely, that the combination frequencies need not be considered as potential sources of excitation. A.

534.143 : 550.834 : 621.395.62

An electromechanical source of elastic waves in the ground. *See Abstr.* 5935

534.2 : 535.12 : 538.566

5176. Addendum to "Waves in anisotropic conditions of propagation". H. POEVERLEIN. Note in *Z. Naturforch.*, **6a**, 55 (*Jan.*, 1951) *In German.*

See Abstr. 1667 (1951). Notes that Cotte has shown earlier the differences between the wave-, index- and normal-surfaces of matter waves and the corresponding surfaces in light optics; and also that he noted the influence of the choice of vector potential on the form of the wave-surfaces. H. H. HOPKINS

534.21

5177. Analysis of multiple-echo effect arising from the release of a stored wave train. L. GOLD. *J. Acoust. Soc. Amer.*, **23**, 214–18 (*March*, 1951).

A generalized theoretical treatment is presented of a problem which has direct application to the phenomenon of multiple-echo patterns as employed for propagational studies of h.-f. sound waves in various media. An analysis is made of the functional dependence of the number of observable echoes N in terms of a prescribed threshold sensitivity db^* of a detecting device, and the storage medium parameters, which are the effective absorption coefficient a and the boundary reflection coefficient R. The equation derived is: $N = \{db^*/10 + \log R - \log(1 - R)\}/\{\log R - \alpha d \log e\}$, where d is the length of the storage system. This relation has values R_{opt} for which N is a maximum, and it is shown that $N_{max} = 1/(1 - R_{opt})$. A.

534.22 : 534.321.6

5178. Ultrasonic velocities in gases at low pressures. R. A. BOYER. *J. Acoust. Soc. Amer.*, **23**, 176–8 (*March*, 1951).

An ultrasonic interferometer with high sensitivity is used to measure acoustic velocities at 0° C in gases, as the wavelength approaches the mean free path of the molecules. Measurements are made of velocity as a function of pressure down to about 2 mm of Hg, the frequency being kept constant at approximately 970 kc/s. The following increases in velocity (at the lowest pressures) over that at standard conditions were observed: A 27%, N_2 16%, O_2 20% and dry CO_2-free air 7%. A.

534.221

5179. Temperature dependence of ultrasonic velocity in alcohols. K. S. IYENGAR. *Proc. Indian Acad. Sci. A*, **33**, 127–9 (*Feb.*, 1951).

534.221

5180. The velocity of sound in sea water. A. WEISSLER AND V. A. DEL GROSSO. *J. Acoust. Soc. Amer.*, **23**, 219–23 (*March*, 1951).

Laboratory measurements of sound velocity in sea water samples from the Caribbean and Middle Atlantic have been made by means of a 3-Mc/s ultrasonic interferometer. The results at various salinities and temperatures show that the velocity values in current use (Kuwahara's tables) are too low by approximately 3 m/sec. In addition, variations in the dissolved air content were found to have a negligible effect on sound velocity and absorption. The sulphate/chloride ratio was determined as quite constant in a given region of the sea. Finally, it was established that the velocity and adiabatic compressibility observed for sea water are explainable on the basis of a linear summation of the effects of the individual dissolved salts. A.

534.222.2

5181. The general consistency relations for shock waves. W. F. BROWN. *J. Math. Phys.*, **29**, 252–62 (*Jan.*, 1951).

Theoretical. Thomas [Abstr. 1573 (1950)] derived a set of relations between the curvatures of the shock and the streamlines behind it, and their derivatives, for the case of a uniform incident stream of ideal gas; the effects of viscosity and thermal conductivity were neglected. In the present paper, the treatment is extended to include non-uniform rotational incident flow. The results are applied to a consideration of the formation and stability of shocks attached to a solid boundary having a smooth contour, but a discontinuity in curvature. It is shown that if an attached shock exists, it must be normal to the boundary at the point of contact, and that such a shock wave is unstable. The existence in practice of stable normal shocks may be due to attachment of the other extremity of the shock line to a solid boundary with which it is in stable contact, to reflection at the sonic line in transonic flow, or to stabilizing influences in the boundary layer. A. SCHOFIELD

534.222.2 : 532.12

5182. On shock-wave phenomena: waterlike substances. R. J. SEEGER AND H. POLACHEK. *J. Appl. Phys.*, **22**, 640–54 (*May*, 1951).

The properties of shock waves in waterlike substances are investigated in detail. A waterlike substance is defined as one for which the intrinsic energy is separable into a sum of two terms, one of which is a function of density only and the second a function of specific entropy. The basic equations that govern the propagation of plane shock waves in a waterlike substance are derived. One-dimensional interaction of shock waves, rarefaction waves, and contact discontinuities in a medium of this type are analysed. It is shown that a number of intrinsic differences exist between the behaviour of shock waves in waterlike substances and their behaviour in ideal gases. One-dimensional interaction of shock waves in arbitrary fluids is discussed; the theory of regular reflection of shock waves in waterlike substances and the theory of triple-shock intersections are presented. In both instances essential differences between the behaviour of shock waves in waterlike substances and ideal gases are noted. The text is supplemented by numerous tables and charts. A.

534.222.2 : 541.127

5183. X-ray flash photographs of shock waves in solid, liquid and gaseous media. R. SCHALL AND G. THOMER. *Z. angew. Phys.*, **3** (*No.* 2) 41–4 (1951) *In German.*

Intense shockwaves were generated by the detonation of explosive pellets or by the sudden vaporization of metallic foil by a heavy electric current. The density variation within the shock can be evaluated from the photographic density of an X-ray shadow-graph,

and if the shock propagation velocity is known, the pressure distribution can be calculated from the Rankine–Hugoniot eqns. An examination of the propagation of intense shocks in ethyl ether, acetone, ethyl alcohol and water shows that at high compression (corresponding to a twofold density increase) the diff. in compressibility of the 4 liquids is much reduced: whereas at lower pressures the compressibility of ether is 3·6 times that of water, under these conditions the ratio falls to approx. 1·4. The press. behind the intersection of 2 shockwaves is much greater than in either separately; use is made of this principle to extend the pressure region under examination. A study of the density distribution in a detonation wave is described, in which the effect of explosive grain size upon reaction zone thickness was examined. To achieve adequate X-ray absorption by gases, it is necessary to load the gas with heavy atoms; the addition of methyl iodide was found effective. This technique was applied to an investigation of the density distribution in a plane shock-wave in air; in a further study on the behaviour of cylindrically expanding and collapsing waves, the marked increase in density and in velocity of the collapsing wave as its radius approaches zero, was clearly demonstrated.

A. SCHOFIELD

534.23

5184. Transmission of sound through steel plates immersed in water. R. D. FAY and O. V. FORTIER. *J. Acoust. Soc. Amer.*, **23**, 339–46 (*May*, 1951).

The measured transmittivity of a steel plate in water is presented as a function of the angle of incidence and the product of frequency and plate thickness over wide ranges. The normal velocity of the plate surface can attain an amplitude necessary for good transmission only by constructive interference among internal reflections. It is shown that the ideal conditions can be met in a plate of finite width in only a few cases. In general, the conditions for a transmission maximum are the conditions for the existence of appropriate types of stable travelling waves in a plate of infinite extent; these conditions, however, are modified by edge effects. An apparent effect of this modification is to produce changes in the divergence of the transmitted beam and hence in the observed transmittivity. A.

534.23

5185. Random noise in an attenuating fluid medium. R. E. ROBERSON. *J. Acoust. Soc. Amer.*, **23**, 353–8 (*May*, 1951).

It is assumed that acoustic background noise is caused by a distribution of random "white" noise sources whose physical mechanism is unspecified. A law expressing the amplitude-distance attenuation characteristic of the medium is also assumed. Several distributions of noise sources are considered: uniform volume distributions, uniform surface dipole distributions and two mixed cases. The noise drop-off with frequency at a point below the surface is found for each case. For an infinite volume of noise sources, this drop-off is 6 db/octave at all frequencies. It is shown how this simple model can be generalized to other attenuation laws and other spatial and amplitude distributions of noise sources. A.

534.23

5186. On the absorption of high power sound waves in water. A. O. WILLIAMS, JR. Letter in *J. Acoust. Soc. Amer.*, **23**, 369 (*May*, 1951).

534.23

5187. Absorption of sound by gas bubbles at a water-metal interface. P. J. WESTERVELT. Letter in *J. Acoust. Soc. Amer.*, **23**, 369 (*May*, 1951).

534.23

5188. Measurements of ultrasonic absorption in various mixtures of nitrobenzene. D. SETTE. *J. Acoust. Soc. Amer.*, **23**, 359–63 (*May*, 1951).

To obtain information on the characteristics of relaxation phenomena in liquids, measurements of ultrasonic absorption were performed in seven binary mixtures having nitrobenzene as one component. The absorption coefficients in some systems (benzene, chloroform) confirm the results obtained previously in mixtures formed by an unassociated, very absorbing liquid and another component with much smaller absorption coefficient. In this case, the absorption coefficient decreases quickly when small quantities of the second liquid are added to the first one. In other mixtures the two components have similar absorption coefficients. If the two liquids are unassociated and their molecules do not interact strongly between themselves, the curve of the absorption coefficient *v.* concentration presents a very clear minimum. If, instead, there are strong interactions, the shape of the curve is altered. This would indicate the presence of an additional type of energy loss. In the systems of nitrobenzene and an alcohol, the absorption coefficient, as a function of the mole fraction, has a maximum at an intermediate concentration, just as happens in some mixtures of water and alcohols. A.

534.23:578.088.2

5189. Physical factors involved in ultrasonically induced changes in living systems: II. Amplitude duration relations and the effect of hydrostatic pressure for nerve tissue. W. J. FRY, D. TUCKER, F. J. FRY AND V. J. WULFF. *J. Acoust. Soc. Amer.*, **23**, 364–8 (*May*, 1951).

Abstr. 1684 (1951), part I. The results of experiments with frogs under a hydrostatic pressure demonstrate that cavitation is not an important factor in the mechanism of production of paralysis of the hind legs of frog by ultrasonic (1 Mc/s) irradiation over the lumbar enlargement region of the spinal cord. Experimental results indicate that a linear relation exists between the reciprocal of the minimum exposure time for paralysis and the acoustic amplitude. It is concluded on the basis of a theoretical calculation that absorption of ultrasound at interfaces in the spinal cord does not result in minute hot regions. Further work on summation of subparalytic doses indicates that the recovery process may not be a monotonic function of time.

534.23 : 532.528

5190. Cavitation in ultrasonic depolymerization. A. WEISSLER. Letter in *J. Acoust. Soc. Amer.*, **23**, 370 (*May*, 1951).

534.23 : 534.845

5191. Absorption of sound by resonant panels. G. G. Sacerdote and A. Gigli. *J. Acoust. Soc. Amer.*, **23**, 349–52 (*May*, 1951).

The experiments have been carried out with sound waves by normal incidence on the panel, and by random sound. The measured values are compared with the theoretical ones. A.

534.23 : 541.182.5

5192. Ultrasonic studies of gels. A. M. Srivastava. Letter in *J. Acoust. Soc. Amer.*, **23**, 232–3 (*March*, 1951).

534.23 : 541.64

5193. Effect of ultrasonic waves on high polymeric substances. E. Wada and H. Nakane. *J. Sci. Res. Inst., Tokyo*, **45**, 1–7 (*March*, 1951).

Degradation effect of ultrasonic waves on polymethyl methacrylate in chloroform was studied under measured wave intensity. It was observed that, in the ultrasonic field, the viscous nature of the solution having anomalous viscosity gradually approached to the Newtonian type. The intrinsic viscosity of the solution was very much affected even in a field as weak as 1·0 W/cm². There was only a slight tendency towards recovery in viscosity when the irradiation of 1·3 W/cm² was stopped. A.

534.231

5194. A new expansion for the velocity potential of a piston source. A. H. Carter and A. O. Williams, Jr. *J. Acoust. Soc. Amer.*, **23**, 179–84 (*March*, 1951).

The Rayleigh surface integral, giving the velocity potential for a plane piston source surrounded by an infinite rigid flange, reduces to a line integral when the coordinates are suitably chosen. As shown by Schoch, for points within the geometrical cylinder whose base is formed by the piston surface, the line integral is expressible as a plane wave term plus a "perturbation" integral. For external points, a different integral results. In the present work, these two complementary expressions are evaluated for a circular piston, as series of half-integral order Hankel functions in kz and polynomials in x/a; k is the propagation constant, a the piston radius, z the axial and x the radial coordinate of a field point. The resulting rigorous equation (valid for points not on the piston surface) converges for any value of ka, provided $z > a$. For large values of kz, where asymptotic formulas apply, the expression assumes a particularly simple form. Sample calculations have been made for $ka = 10$, $z = 10a$ and $ka = 50$, $z = 50a$. Also, an approximate expansion has been derived which may be more useful than the rigorous result in paraxial regions. A.

534.231

5195. On the acoustical radiation of an emitter vibrating in an infinite wall. J. Pachner. *J. Acoust. Soc. Amer.*, **23**, 185–97 (*March*, 1951).

The velocity potential distribution of a circular emitter vibrating in an infinite wall is calculated by the King method for the points immediately before the wall. The close connection is shown between the Rayleigh formula and the expression for the velocity potential which follows from the King method. The equation for the space distribution of the velocity potential expanded in spherical wave functions is transcribed into an abstract form by means of the Dirac bra-vector, ket-vector and linear operator represented by the corresponding matrices. The space distribution of the velocity potential is then computed from the known values in the plane immediately before the emitter by the well-known method of undetermined coefficients written in its matrix form. Thereafter the space distribution of the velocity potential is determined by another, new method due to H. Stenzel. In both methods explicit expressions are given for the case of a vibrating rigid disk, membrane and plate. A.

534.231

5196. On the acoustical radiation of an emitter vibrating freely or in a wall of finite dimensions. J. Pachner. *J. Acoust. Soc. Amer.*, **23**, 198–208 (*March*, 1951).

The field excited by such an emitter is considered as superposed by 2 fields. The first is that where the same emitter is vibrating in an infinite wall and the second that which (i) causes the resultant field in the free part of the plane going through the wall to vanish, and (ii) has a normal derivative which vanishes on the surface of the emitter and wall. While the first field may be considered as known from other papers, the second is computed from an integro-differential equation that follows from Rayleigh's formula. The equations expressing the velocity potential distribution and those deduced from it are written in an abstract form by means of the Dirac bra-vectors, ket-vectors and linear operators represented by the corresponding matrices. This method may be used for any mode of vibrations of the emitter and for any shape of the wall, but becomes easier if the wall is circular. A.

534.231.3

5197. Acoustical impedance in terms of energy functions. P. J. Westervelt. *J. Acoust. Soc. Amer.*, **23**, 347–9 (*May*, 1951).

The procedure is applied to interpret the observed decrease in kinetic mass of circular apertures at large amplitudes. A.

534.232

5198. Note on the impedance variations of an electro-acoustic transducer in a reflecting field. S. Byard. *Proc. Phys. Soc., Lond.*, **61**, 478–80 (*Nov.*, 1948).

534.232

5199. Measurements of the underwater sound field generated by quartz transducers. W. Keck, G. S. Heller and A. O. Williams, Jr. *J. Acoust. Soc. Amer.*, **23**, 168–72 (*March*, 1951).

The mean-square pressure distributions in the ultrasonic fields generated in water by quartz transducers of various shapes were presented on an oscilloscope screen and photographed. The beams, pulsed at an audiofrequency, were swept back and forth across a small pressure-sensitive microphone placed at various distances from the source. The pulse envelopes were square-law detected and amplified before presentation. All the transducers were of X-cut quartz, excited near their resonance frequency of about 1 Mc/s. Square pieces with circular and

ring-shaped electrodes, as well as circular and ring-shaped pieces, were used; all were about 2 cm in diameter. Comparisons with theory were made for radial and axial mean-square pressure distributions. From study of the axial distributions it was concluded that simple piston theory adequately describes these transducers, provided the baffles and electrodes satisfy certain geometrical conditions. It appears that 18·5° X-cut crystals tend to vibrate over the whole exposed surfaces even outside the electrode regions. A.

534.232

5200. A barium titanate transducer capable of large motion at an ultrasonic frequency. W. P. MASON AND R. F. WICK. *J. Acoust. Soc. Amer.*, **23**, 209–14 (*March*, 1951).

By using a Ba titanate cylinder poled radially a lengthwise motion can be excited in the cylinder whose resonant frequency is controlled by the length of the cylinder. By using a 4% Pb titanate/Ba titanate combination, stresses up to 1 000 lb/in^2 of cross-sectional dimension and motions up to 50 parts in 10^6 times the length of the cylinder are available for static or slowly varying voltages of 15 000 V/cm along the radial dimension. When such a cylinder is driven at its resonant frequency, the maximum strain appears to be limited to 10^{-4} by heating considerations if no cooling is used. For a cylinder 12 cm long, which resonates at 18 kc/s, this corresponds to a displacement on each end of $3{\cdot}9\times10^{-4}$ cm, a particle velocity of 44 cm/sec and an acceleration of 5×10^6 cm/sec/sec. All of these quantities can be enhanced by a factor of 10 by soldering a solid brass "horn," tapered exponential, to the end of the Ba titanate cylinder. Applications are described. A.

534.232 : 534.88 : 538.652

5201. Generation of ultrasonics by means of volume magnetostriction. H. H. RUST. *Z. angew Phys.*, **3** (*No.* 1) 9–14 (1951) *In German.*

The volume changes which occur in a magnetized ferromagnetic body can be used for generating ultrasonics. Finely divided magnetic powder (carbonyl Fe with 0·7% C) is suspended in a suitable oil in a container one side of which has a "window" of low absorption properties (trolitol or Cu foil). The exciting coil is completely immersed in the suspension. If aperiodic pulses are required, as for use in ultrasonic reflection methods, the exciting coil is driven by a condenser-discharge circuit which includes a special discharge valve; because of the form of the magnetostriction curve, the ultrasonic pulse width is less than that of the electrical pulse. The method has advantages when applied to echo-sounding and results obtained in a ship are described. H. J. H. STARKS

534.24

5202. On the reflection of a spherical sound wave from an infinite plane. U. INGARD. *J. Acoust. Soc. Amer.*, **23**, 329–35 (*May*, 1951).

The reflection of a spherical sound wave from a wall with the boundary conditions expressed in terms of a normal impedance independent of the angle of incidence is treated. It is shown that the integral for the reflected wave can be evaluated exactly in closed form under certain conditions. The solution given for an arbitrary normal impedance involves a slight approximation of the integral. The reflected wave is brought into a form such that it can be considered as originating from an "image source" having a certain amplitude and phase. Graphs for determining this amplitude and phase are given in terms of a "numerical distance," which depends on the normal impedance and the position of the field point. Pressure distributions around point sources for different wall impedances are shown. The limitations in simulating plane wave conditions at a boundary and the corresponding effect on free-field methods of measuring acoustic impedance are discussed. A.

534.24

5203. On the nonspecular reflection of sound from planes with absorbent bosses. V. TWERSKY. *J. Acoust. Soc. Amer.*, **23**, 336–8 (*May*, 1951).

Exact solutions are obtained for the problem of the single boss and then extended, subject to the single-scattering hypothesis, to obtain far field solutions for certain planar distributions of bosses of radii small compared with the wavelength. The results are compared with those obtained previously for non-absorbent bosses, and it is shown that the effects of the finite impedance are most pronounced in the simple source terms of the scattered components and may lead to either a decrease or an increase in the radiation reflected at the specular angle. Another effect of the finite impedance (for the small finite distributions) is to shift the critical value of the angle of incidence for which the reflection at the specular angle consists only of the specular component. The effect of the finite impedance of the bosses is most pronounced for these distributions yielding terms much larger than those previously retained for the non-absorbent bosses. A.

534.26

5204. Sound scattering of a plane wave from a non-absorbing sphere. R. W. HART. *J. Acoust. Soc. Amer.*, **23**, 323–9 (*May*, 1951).

Sound scattering from a sphere of arbitrary size is treated theoretically when the acoustic properties of the sphere are near those of the surrounding medium. Closed-form analytic expressions are found for the reflectivity and total cross-section. These expressions become exact only in the limit as the ratio of the densities and ratio of the speeds approaches unity, but it is shown that for ratios as large as 5/4 and probably as large as 3/2 the approximate reflectivity and total cross-section compare favourably with results of exact calculation. Calculations of reflectivity and total cross-section, which would require weeks if made from the exact solution of the wave equation, may be completed in a few hours using the approximate closed-form expressions. A.

534.26 : 534.23

5205. Scattering and absorption by an acoustic strip. A. LEVITAS AND M. LAX. *J. Acoust. Soc. Amer.*, **23**, 316–22 (*May*, 1951).

A method for treating the scattering and absorption of sound in the presence of non-uniform boundary conditions is applied to the case of an infinite strip of material (of given width) placed on an infinite, otherwise hard, wall. The strip is assumed to be characterized by a normal acoustic impedance that may possess

a resistive component. The wave equation is reformulated as an integral equation over the strip. A variational expression is found for the amplitude of sound scattered by the strip in any direction. The total cross-section for scattering plus absorption is determined from the amplitude of specular reflection. A.

534.3

5206. Acoustics of the organ. F. TRENDELENBURG. *Ric. Sci.*, **21**, 339–52 (*March*, 1951) *In Italian.*

The production of tones in organ pipes is discussed. The use of an electronic analyser shows that the transitory period in reed pipes is followed by a rapidly increasing tone while in flue pipes the sound grows but slowly. Two types of wind chest construction are used: the *Tonkanzelle*, where all pipes of the various registers pertaining to one key communicate with the same chamber; on depressing the key the air pressure grows slowly and the initial transitory of flue pipes is slow; pitch rises imperceptibly, returning to normal within about 0·5 sec; the other type of wind chest is the *Registerkanzelle*, used in modern instruments; all pipes of the same register are connected by a duct in which air pressure is maintained and supplied to each pipe without temporal delay upon depressing the key. Some general points of architectural acoustics are briefly touched upon. W. SUMMER

534.321.3

5207. Fokker's organ in Huygens' tuning. M. F. MEYER. Letter in *J. Acoust. Soc. Amer.*, **23**, 369 (*May*, 1951).

534.321.9 : 616–7

5208. An ultrasonic method for outlining the cerebral ventricles. T. F. HUETER AND R. H. BOLT. *J. Acoust. Soc. Amer.*, **23**, 160–7 (*March*, 1951).

Discusses the general physical problems underlying the portrayal of ventricular geometry by ultrasonic techniques. This offers another means somewhat analogous to X-ray ventriculography for the detection of brain tumors. Progress is reported on studies of ultra-sound propagation properties in the tissues involved. Preliminary conclusions on safety thresholds of pain and damage are discussed. The most promising method to date is straight-through transcranial transmission (not echo ranging) utilizing changes in attenuation owing to differing amounts of ventricle along the transmission path. The optimum compromise frequency appears to be about 2·5 Mc/s for which frequency results are reported on studies of receiver sensitivity and dynamic range, resolution, shielding, transducers and presentation problems. A.

534.321.9 : 620.179.16

5209. Improvements in the design of ultrasonic lamination detection equipment. H. R. CLAYTON AND R. S. YOUNG. *J. Sci. Instrum.*, **28**, 129–32 (*May*, 1951).

The development of an apparatus for the detection of lamination on aluminium blanks and sheet is described. The simple transmission technique as used by Sokolov has been modified in order to minimize the effect of standing waves which are formed in sheets of specific thicknesses. This end is achieved by energizing the transmitter crystal by a wide band of ultrasonic frequencies and by providing a receiver capable of detecting all the frequencies transmitted. Tests have shown that a defect of less than $\frac{3}{4}$ in dia. can be detected and that the contours of a lamination can be traced with a satisfactory accuracy. Metal thickness has little or no effect on the indications of the instrument, thus proving that the design is successful in minimizing the effect of the formation of standing waves. A.

534.39

5210. The theory of steady forces caused by sound waves. P. J. WESTERVELT. *J. Acoust. Soc. Amer.*, **23**, 312–15 (*May*, 1951).

A general expression is derived for the force owing to radiation pressure acting on an object of any shape and having an arbitrary normal boundary impedance. It is shown that boundary layer losses may lead to forces that are several orders of magnitude greater than the forces owing to classical radiation pressure. Steady forces arising from an asymmetric wave form are compared with the other forces. A sound wave, consisting of equal parts of fundamental and second harmonic components, can cause forces 10 or more orders of magnitude greater than the forces owing to radiation pressure to be exerted on small particles. A.

534.41

5211. Sound analysis without resonance. M. F. MEYER. Letter in *J. Acoust. Soc. Amer.*, **23**, 232 (*March*, 1951).

534.414

5212. The wavelength of a spherical resonator with a circular aperture. H. LEVINE. *J. Acoust. Soc. Amer.*, **23**, 307–11 (*May*, 1951).

The result, $\lambda/2\pi = R(2\pi R/3a)^{\frac{1}{2}}(1 - 0{\cdot}14324a/R + 0{\cdot}08455(a/R)^2)$, where a denotes the aperture and R the sphere radius, is the correct form of an expansion as far as terms of relative order $(a/R)^2$, inclusive. A procedure for approximating to the wavelength of a resonator with arbitrary shape is also described. A.

534.61

5213. Effects of reflected signals and electric pick-up at an ultrasonic microphone. A. O. WILLIAMS, JR., AND W. KECK. *J. Acoust. Soc. Amer.*, **23**, 173–5 (*March*, 1951).

When a small microphone is used in an ultrasonic beam, the direct acoustic signal is mixed with electric pick-up and reflected signals. The use of pulses may not entirely remove these interferences. The mixing process is analysed here for a particular situation and experimental evidence is adduced to support these conclusions: (1) that the main response pattern of the microphone shows space variations of both half the acoustic wavelength and the full wavelength; (2) that the former variation dies out at sufficiently great distances from the source at a rate showing that a single echo path (source-microphone-source-microphone) is responsible along with a constant electric signal; and (3) that the 3 signals can be resolved analytically. A.

534.61

5214. The error due to masking in the measurement of aural harmonics by the method of best beats. J. P. EGAN AND R. G. KLUMPP. *J. Acoust. Soc. Amer.*, **23**, 275–86 (*May*, 1951).

It has been generally assumed that the listener hears best beats when the exploring tone produces in the cochlea a disturbance that is equal in magnitude to that of the aural harmonic or of the combination tone being measured. However, it is shown that their intensities will be overestimated when this method is used. A procedure is presented by which a better estimate of the intensity of an aural harmonic or of a combination tone may be made. Application to the measurement of a second aural harmonic is illustrated. An explanation is given of the fact that the intensity of a tone near its absolute threshold will be overestimated by use of the method of best beats. This explanation is formulated in terms of the relation of the minimum and the maximum of the envelope of the beating complex to the listener's threshold for the tones that beat. A.

534.733.2 : 621.389

5215. The design of commercial hearing aids. J. P. ASHTON. *J. Brit. Instn Radio Engrs*, **11**, 51–9 (*Feb.*, 1951).

Two modern types are illustrated and briefly described, one of moderate standard, the other more compact and expensive in battery replacement. The conventional circuit consists of three sub-miniature pentode or beam-tetrode stages with RC inter-valve coupling and transformer or direct output coupling. An a.v.c. compression system is usually included. The valves have low noise, low microphony, long life, and provide a stage gain of ~ 32. A scaled-down version of the normal telephone earphone has now superseded the earlier crystal earphone. Acrylic earmoulds, individually moulded, conduct the sound to the eardrum and hold the unit in place. The bone oscillator is similarly constructed. The Rochelle-salt microphone, which needs mechanical protection and moisture sealing, is almost universally used. Types of batteries employed are also described. These include layer-type h.t. batteries and l.t. batteries using Hg as the active element.

H. G. M. SPRATT

534.773

5216. A strain-gauge type artificial mastoid. R. W. CARLISLE AND H. A. PEARSON. *J. Acoust. Soc. Amer.*, **23**, 300–2 (*May*, 1951).

An artificial mastoid for testing bone conduction receivers is described. It consists essentially of a stiff metal bar which has a fundamental resonant frequency above the measurement range, with a strain-sensitive translating element fastened to the under side and a compliant pad on top. The translating element is a slab of activated ceramic, which is essentially invariant to humidity and temperature changes. The compliant pad generally used is Koroseal No. 74, which simulates the flesh over the mastoid prominence reasonably well. Koroseal No. 15 simulates flesh better but is less robust. Calibration methods are discussed. A.

534.78

5217. Erratum: The calculation of vowel resonances, and an electrical vocal tract. H. K. DUNN. Letter in *J. Acoust. Soc. Amer.*, **23**, 234 (*March*, 1951).

See Abstr. 1696 (1951).

534.78

5218. Effect of delay distortion upon the intelligibility and quality of speech. J. L. FLANAGAN. *J. Acoust. Soc. Amer.*, **23**, 303–7 (*May*, 1951).

Speech articulation and quality tests were made on an all-pass system capable of advancing or delaying one frequency band relative to the rest of the spectrum. Parameters in the investigation were (*a*) width of the advanced or delayed band, (*b*) amount of advance or delay, and (*c*) position in the frequency spectrum of the advanced or delayed band. Data were taken at signal-to-noise ratios of 30 db and 0 db. The results indicate that maximum impairment of speech intelligibility and quality occurs when the delays and advances are of the order of $\frac{1}{4}$ sec, and when the band that is advanced or delayed is near the centre of the speech spectrum and has an articulation index equal to 0·5. These findings are related to data from statistical studies of the timing of speech energy bursts. A.

534.79

5219. Calculation and measurement of the loudness of sounds. L. L. BERANEK, J. L. MARSHALL, A. L. CUDWORTH AND A. P. G. PETERSON. *J. Acoust. Soc. Amer.*, **23**, 261–9 (*May*, 1951).

An equivalent-tone method for calculating the loudness of sounds is described. With this method the spectrum of the sound is divided into frequency bands which are treated as pure tones in determining their loudness. The individual values of loudness are added to obtain the total loudness of the sound. Calculations for bands of white noise and for complex tones are compared with subjectively obtained data of Pollack and Fletcher and Munson. The agreement between calculated and experimental values is good. It is felt that improvement of the method must await further psychoacoustic data. A.

534.833.1

5220. Investigation of the airborne sound insulation by single and double walls. A. PANCERAM. *Tech. Hausmitt. Nordwdtsch. Rdfunks*, **3**, 5–14 (*Jan.–Feb.*, 1951) *In German.*

A large number of observations are plotted graphically to show the relation between intensity of transmitted sound and the wall density (kg/m²) over a wide range of frequencies. This is done for single and double walls (separated by an air space or by "iporka" filling). A comprehensive table indicates the sound insulating properties of walls made of different materials. A. B. WOOD

534.84

5221. The arrangement of sound sources in rooms and auditoria. F. BERGTOLD. *Fernmeldetech. Z. [FTZ]* **4**, 112–16 (*March*, 1951) *In German.*

The paper is concerned mainly with the design of loud-speaker systems for large auditoria. Banks of

loud-speakers are arranged (*a*) flush with the walls, (*b*) recessed in the wall but set alternately looking left and right at an angle to the wall, and (*c*) two banks of speakers in walls (or baffles) inclined to each other at a suitable angle. Sections of the paper deal with the problems of equalizing the sound intensity over the listening area, equal frequency range for all listeners, background noise, reverberation effects, directionality and strength of sound sources. Detailed consideration is given to the use of sound radiator groups in a church, making allowance for directionality in the horizontal and vertical planes. An attempt is made to spread the sound fanwise as widely as possible over the audience whilst limiting the spread in a vertical direction to avoid reflections. The sound intensity is also controlled to a minimum value to limit disturbing reflections. A. B. WOOD

534.861.1 : 621.396.712.3

5222. Broadcasting auditoria with diffusing walls. C. TUTINO AND G. G. SACERDOTE. *Telecomunicazione*, **4**, 5–15 (*Jan.*, 1951) *In Italian.*

An illustrated description of studios at Milan and Turin, with measured reverberation time/frequency characteristics before and after treatment, together with experimental frequency response curves for a scale model studio under a range of conditions. The main treatment consists in covering the walls with vertical and horizontal arrays of semi-cylindrical surfaces of various dimensions, constructed of a pumice-stone/plaster mixture and finished smooth. The resulting "liveliness" is attractive for several types of programmes. F. F. ROBERTS (R)

OPTICS . RADIATION . SPECTRA 535

535.214.6

5223. Photophoresis of particles of coloured fog. Speed as a function of concentration of disperse solutions and of particle size. M. MAITROT. *C.R. Acad. Sci., Paris*, **232**, 823–5 (*Feb.* 26, 1951) *In French.*

Fine drops of Diesel oil show no photophoresis at any pressure. Solutions of organol red show both positive and negative effects depending on conc., drop size and wavelength of light. Solns. of organol blue and green show only negative effect. N. CORCORAN

535.23

5224. The use of line co-ordinates for the study of radiation. E. BOREL. *C.R. Acad. Sci., Paris*, **232**, 1329–31 (*April* 2, 1951) *In French.*

Demonstrates a simple method, based upon line geometry, of deriving the elementary properties of radiation. R. W. FISH

535.23.08

5225. A new absolute radiometer. G. A. W. RUTGERS. *Physica*, **17**, 129–36 (*Feb.*, 1951).

A radiometer is described, consisting of a mica foil, coated on the front side with a blackened layer of evaporated manganin and on the back with a layer of evaporated Al. The rise of temperature, caused by absorption of incident radiation or by an electric current passing through the front layer, is measured by means of a consequent change in the resistance of the back layer. Comparison of six of these bolometer strips has shown that absolute radiation measurements with this bolometer are reproducible within 0·2%. The accuracy in the measured energy is estimated to be better than 0·5%. A.

535.234

5226. The second radiation constant in Planck's radiation formula. II. G. A. W. RUTGERS. *Physica*, **17**, 137–48 (*Feb.*, 1951).

See Abstr. 2290 (1950) for Pt I. The spectral radiant intensity of a black body at the melting point of Au was measured in the wavelength range from 0·5 to 1·0 micron. The experimental arrangement and the calibration of the spectral pyrometer used in these experiments are described. The value of c_2 derived from the experiments is $1{\cdot}436 \pm 0{\cdot}001_5$ cm degree. Some conclusions and a schedule for further measurements are given. A.

535.241.33

5227. A black body: a standard of brightness of adjustable temperature. G. A. BOUTRY AND L. LE BLAN. Note in *Nuovo Cim.*, **8**, 207–22 (*March*, 1951) *In French.*

An account of the use of incandescent W as a source of standard brightness. After a preliminary calibration a given brilliance may be obtained by raising the W to a known temperature. This is effected by passing an accurately controlled current through it. The apparatus described is in use in Paris. N. CORCORAN

535.247

5228. A new deflection type densitometer. W. G. KIRCHGESSNER. *Rev. Sci. Instrum.*, **22**, 289–92 (*May*, 1951).

Fundamental requirements of design are stated and construction is described on the basis of these requirements. Performance data of the instrument are discussed in detail and records are given to demonstrate its fidelity of reproduction. A.

535.247.4

5229. A tristimulus photometer. G. C. SZIKLAI. *J. Opt. Soc. Amer.*, **41**, 321–3 (*May*, 1951).

In order to avoid the tedious job of product integration involved in obtaining the ICI co-ordinates it was proposed to construct an instrument with a certain photocell-filter combination approximating the ICI standard distribution factors. However, the extent of approximation is limited particularly for the $\bar{X}$ curve with its double components. The new instrument provides a good approximation of the ICI co-ordinates by means of a novel unidirectional cross-feed arrangement, which injects a portion of the $\bar{Z}$ response into the $\bar{X}$ response circuit. Three integrated signals can be read on three meters simultaneously, and the ICI co-ordinates can be computed by one addition and two dividing operations. A.

535.247.4 : 621.395.645.024 : 621.317.18

5230. A balance indicator with high input impedance using a cathode follower. D. T. R. DIGHTON. *J. Sci. Instrum.*, **28**, 101–2 (*April*, 1951).

The use of the cathode follower circuit with high-value grid resistances is discussed and it is shown that a high-slope pentode can give an impedance conversion of 10^7. A cathode follower circuit suitable for a null-balance indicator for photometric work is

described. The input impedance is 500 MΩ, the grid current about 10^{-10} A and the detection limit 1 to 2 mV change of grid potential. A simple method of compensating for slow variations of heater voltage is employed. A.

535.247.4 : 771.534.55

5231. Photographic granularity and graininess. VII. A microphotometer for the measurement of granularity. L. A. Jones and G. C. Higgins. *J. Opt. Soc. Amer.*, **41**, 192–200 (*March*, 1951).

Abstr. 4985 (1951) part VI. Granularity of photographic deposits is measured in terms of two-dimensional variations in their transmitting properties. These measurements can be made in terms of either density or transmittance, and the diameters of the circular areas on which the measurements are made can be varied from 1·5 μ to 78 μ on the sample. Either ΔD or ΔT, the conventional density or transmittance differences from the mean, or $S\Delta D$, or $S\Delta T$, the syzygetic density or transmittance differences between immediately adjacent surface elements of equal area, are measured and recorded automatically. The instrument will make a reading, record this reading, and move the sample to a new area at the rate of approximately one reading every three seconds. When a sufficient number of readings, normally at least 300, have been made, the recorder plots the results as a frequency distribution curve. A.

535.247.4–15 : 535.33.07

5332. Designs of photometer units for infrared spectrographs. R. A. Oetjen and L. C. Roess. *J. Opt. Soc. Amer.*, **41**, 203–8 (*March*, 1951).

An attempt is made to obtain the design of a photometer unit which may be used with an infrared spectrograph so that percent transmission or some related quantity may be recorded directly. Several basic methods of accomplishing this are evaluated. It is concluded that the following should characterize the design: the optical system should be symmetrical; there should be only one path through the spectrograph; only one detector and amplifier should be employed; and these should actuate, through an appropriate servomechanism, a device to maintain equality of intensity in the two radiation beams, so that a null system results. Several possible basic designs for some of the components of the photometer are discussed. A.

535.313

5233. Geometrical optics of concave mirrors and of combinations of mirrors. J. Shearer. *Aust. J. Sci. Res. A*, **3**, 532–40 (*Dec.*, 1950).

A study is made over the range of incidence from normal to grazing. An examination is made of methods of correcting for astigmatism at oblique incidence by the use of "crossed" mirrors (spherical and cylindrical), of "parallel" cylindrical mirrors, and of a single mirror with different radii of curvature in planes at right angles. Such a single mirror combines in one piece image formation and beam deviation. A.

535.315 : 535.39

5234. The transmittance of a prism. H. F. Weaver. *J. Opt. Soc. Amer.*, **41**, 331–5 (*May*, 1951).

The transmittance of a prism for a circular collimated beam of light tangent to the refracting edge of the prism is derived analytically in terms of the 1st-order modified Bessel function of the first kind. The variables involved in the formula are k_λ, the absorption coefficient of the glass at wavelength λ, and $B_s = B/2$, the "semibase" of the prism. The variables occur in the combination $k_\lambda B_s$. The transmittance, T_λ, computed for a circular beam of diameter d differs little from that computed for a square beam of size $d \times d$. The problem of placing a circular collimated beam on the prism so as to obtain the maximum transmittance, $T_{\lambda,\,\max}$, is re-examined following Hartmann's treatment. Tables and graphs for determining the amount by which the prism must be withdrawn from the beam in order to achieve maximum transmittance are given, again with $k_\lambda B_s$ as variable. Tables and graphs of $T_{\lambda,\,\max}/T_\lambda$ are also given. As in the case of square or rectangular beams, the circular-beam transmittance of a combination of several prisms of a given material is found to be identical with that of a single prism of the same material, provided the train of prisms and the single prism give the same angular dispersion. A.

535.317

5235. Lens systems. W. Westphal. *Optik*, **8** (*No.* 3) 125–8 (1951) *In German.*

A simple geometrical construction for the principal planes of a separated pair of lenses is used to deduce the known expressions for their positions.

H. H. HOPKINS

535.321–15

5236. Determination of the ordinary refractive index of calcite in the region 5–14 μ. J. Ramadier-Delbès. *C.R. Acad. Sci., Paris*, **232**, 1194–6 (*March* 19, 1951) *In French.*

The refractive index is found on both sides of the absorption frequency (6·71–6·99 μ) by using interference spectra produced by thin half-metallized films of calcite cut perpendicularly to the optic axis.

R. W. FISH

535.321–15

5237. The measurement of refractive indexes of liquids in the infrared. J. H. Jaffe. *J. Opt. Soc. Amer.*, **41**, 166–9 (*March*, 1951).

A Perkin–Elmer spectrometer is adapted for this purpose without interfering with its normal operation as a routine instrument. Although use is made of a Fabry–Perot etalon, the method is not interferometric in the accepted sense. The accuracy that has been obtained is 0·002 at a wavelength of 1 μ, but in principle the possible accuracy of the method may be equal to that of the best goniometer. A.

535.323–15

5238. Properties of amorphous selenium in the infra-red. H. A. Gebbie and E. W. Saker. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 360–1 (*April*, 1951).

Refractive index = 2·589 and 2·52 at $\lambda = 0{\cdot}819$ and 1·014 μ resp. Transmission is high for $\lambda > 0{\cdot}7$ μ. Se may be a useful optical material.

535.325

5239. The dispersion of air between 2 500 Å and 6 500 Å. H. Barrell. *J. Opt. Soc. Amer.*, **41**, 295–9 (*May*, 1951).

The available experimental data on the optical

dispersion of air have recently been critically assessed by Meggers and Kessler. They find that none is satisfactorily reliable when subjected to a test depending upon the application of the Ritz combination principle to term analysis in the first spectrum of $_{80}Hg^{198}$ lying between 2 536 Å and 5 791 Å. In the present paper, a new dispersion curve for air is derived from reasonably concordant refractivity data previously obtained in the visible spectrum at 3 different laboratories. The Cauchy equation of this curve is used to reduce to vacuum wave numbers the highly precise wavelengths in air of 27 lines of $_{80}Hg^{198}$ measured by Meggers and Kessler. If the truth of the combination principle is assumed, the constancy of recurring term intervals between 2 536 Å and 5 791 Å shows that the new dispersion equation for air is at least as reliable as the original wavelength measurements, for which an average accuracy of ±0·0001 Å was claimed. Alternative forms of the general refractivity/density relationship are quoted which render the new dispersion equation suitable for practical use in spectroscopy and length metrology. A.

535.33

5240. On line emission from the inhomogeneous layer. II. H. BARTELS. *Z. Phys.*, **126** (*No.* 1–2) 108–40 (1949).

The theory developed in part I [Abstr. 4814 (1950)] is extended to the case where the line form of the emitting layer varies. The shape of the contour and its relation to the layer structure are discussed. Differences between the methods used in this and in astrophysical problems are mentioned.

535.33.03

5241. Suppression of certain parts in spark spectra by electronic time switching. H. M. CROSSWHITE, D. W. STEINHAUS AND G. H. DIEKE. *J. Opt. Soc. Amer.*, **41**, 299–302 (*May*, 1951).

An electronic device is described which renders a phototube sensitive only at prescribed but arbitrary intervals of a spark cycle. Such undesirable light as air lines and continuous background can then be suppressed. There is evidence that for spectrochemical analysis purposes the spectrum thus recorded photoelectrically combines the stability and reproducibility of the condensed spark with the sensitivity of the d.c. arc. A.

535.33.03 : 537.523.4

5242. Influence of the air pressure on the intensity ratio of two spectral lines and on the disintegration of the electrodes in the quantitative spectroscopy of alloys. A. SCHÖNTAG AND L. CAMERER. *Z. wiss. Photogr.*, **45** (*No.* 7–9) 173–84 (1950) *In German.*

It is pointed out that improvements in the technique of spectroscopic analysis lead to gradually decreasing errors of measurement. One of the latter is due to the effect of varying air pressure and this is studied for condensed spark discharges. Controlled expts. were made on the variation of the intensity ratios of certain selected pairs of lines for Mn/Al, Ti/Al, Si/Al, Mg/Al, Mg/Zn, Al/Zn, Cu/Zn, Mn/Zn, Sb/Pb and Si/Fe systems as a function of pressure over the range 100–850 mm Hg. Errors of up to 2% can be caused in this way over normal atmospheric pressure ranges. A systematic error of up to 6% due, it is suggested, to this cause was found between certain intensity ratios measured in Berlin and Munich. This effect, and its bearing on electrode erosion are discussed; the latter point is dealt with briefly. J. D. CRAGGS

535.33.07

5243. A multiplier photocell attachment for use with prism spectrographs. J. M. NAISH. *J. Sci. Instrum.*, **28**, 138–40 (*May*, 1951).

A photoelectric adapter is described for making measurements of spectral line intensities in the visible and u.v. regions. Two integral multiplier photocell units are mounted in a modified spectrograph plateholder, and provide outputs proportional to the intensities in two selected wavelengths. The outputs may be compared visually or photographically by oscillographic techniques, or may be measured by an integrator circuit. Details are given of the light-tight construction of the units, the system of rapid and accurate line location, the focus adjustment and the slit mechanism. The performance is treated theoretically by considering the possible resolution, sensitivity and precision of wavelength location. The experimental resolution obtained is 1·5 Å at 3 000 Å. A.

535.33.07–15

5244. Temperature coefficients for use with rocksalt prism spectrometers. J. H. TOWLER AND W. GUY. *J. Sci. Instrum.*, **28**, 105 (*April*, 1951).

Temperature coefficients in the wavelength calibration of an infrared spectrometer have been calculated from the temperature coefficient of refractive index for rocksalt. The results are compared with those obtained by experiment and the agreement is sufficiently good to justify the use of calculated values of temperature coefficients in calibration. A.

535.33.07–34

5245. An apparatus for quantitative low temperature ultra-violet absorption spectroscopy. R. N. BEALE, AND E. M. F. ROE. *J. Sci. Instrum.*, **28**, 109–11 (*April*, 1951).

The main features include ease of construction, efficient cooling of the absorbing medium and rapidity of assembly and alinement. It is designed for use in conjunction with the Spekker photometer and a quartz spectrograph. The lowest temperature attainable is — 165° C. A.

535.33.072

5246. Wavelengths for calibration of prism spectrometers. E. K. PLYLER AND C. W. PETERS. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 462–8 (*Dec.*, 1950).

Several absorption bands of polystyrene, 1,2,4-trichlorobenzene, and other compounds have been measured in the infrared region from 1·5 to 24 μ on grating spectrometers. These bands have been determined with sufficient accuracy for use in calibration of prism instruments. A table is included that gives the cell thicknesses used in the measurements. The emission lines of mercury for the region from 0·5 to 2·4 μ are included. In order that the table may be of most value, a number of bands that have been determined by previous observers have also been included. A.

535.33.072–15

5247. A note on the calibration of infra-red prism spectrometers. W. Guy and J. H. Towler. *J. Sci. Instrum.*, **28**, 103–5 (*April*, 1951).

The method proposed by McKinney and Friedel [Abstr. 1805 (1948)] was used. It was found that their equation could be modified to fit the experimental results more closely. The modified method is applicable to a spectrometer with a rocksalt prism.

A.

535.331

5248. Arc and spark spectra of technetium. W. F. Meggers and B. F. Scribner. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 476–89 (*Dec.*, 1950).

Four milligrams of highly purified technetium were used to obtain a description of the arc and spark spectra characteristic of this fission product. Solutions containing 50 to 200 micrograms of technetium were dried on copper electrodes and excited by electric arcs or sparks. A stigmatic concave grating of 22-ft radius was employed to photograph the spectra from 2 200 to 9 000 Å, within which limits more than 2 300 lines characteristic of Tc atoms or ions were recorded. Wavelengths were measured relative to iron standards, relative intensities were estimated on a scale of 1 to 1 000, and almost every line was definitely assigned either to neutral Tc atoms or to singly charged (Tc^+) ions. The measured wavelengths range from 2 261·30 to 8 829·80 Å with average probable errors rarely exceeding $\pm$ 0·01 Å. The average results of wavelength measurements and of intensity estimates for 2 121 lines in Tc I and Tc II spectra are presented. The strongest Tc I lines have wavelengths 4 297·06, 4 262·26, 4 238·19, 4 031·63 and 3 636·10 Å. The strongest Tc II lines have wavelengths 2 543·24, 2 610·00 and 2 647·02 Å. This description of Tc I and Tc II spectra will serve for spectrochemical identification and for structural analyses of these spectra.

A.

535.331

5249. Absorption and emission spectra of promethium. W. F. Meggers, B. F. Scribner and W. R. Bozman. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 85–98 (*Feb.*, 1951).

The absorption spectrum in solution of 5 mg of Pm separated from fission products was plotted between 3 500 and 10 000 Å; the principal bands have wavelengths 494·5, 548·5, 568·0, 685·5, 735·5 millimicrons ($\pm$ 0·5 millimicrons). Small portions of the sample were dried on copper electrodes employed in photographing alternating-current arc and spark spectra with a concave grating of 22-ft radius. Excepting Sm, into which Pm decays, no other rare earths could be detected in this sample, but common chemical contaminants were troublesome. Between 2 200 and 6 900 Å the wavelengths and relative intensities of more than 2 200 new spectral lines were determined, but it was not possible to differentiate Pm I and Pm II lines with the light sources employed. The strongest Pm lines have wavelengths 3 892·16, 3 910·26, 3 919·09, 3 957·74 and 3 998·96 $\pm$ 0·02 Å. Hyperfine structure is suspected in some Pm lines, indicating that the nuclei of Pm^{147} atoms possess mechanical and magnetic moments. Both the absorption and the emission spectrum identify this fission product as a new element of rare-earth type; they provide positive proof that the long-sought element with atomic number 61 has been discovered.

A.

535.331

5250. Note on the structure of the Ta I spectrum. P. F. A. Klinkenberg, G. J. van den Berg and J. C. van den Bosch. Letter in *Physica*, **17**, 167–8 (*Feb.*, 1951).

See Abstr. 3430 (1951). Since then 9 even levels and some 70 odd levels have been found. The number of classified Ta I lines now exceeds 1 100.

535.332

5251. The spectrum of He^3 I. M. Fred, F. S. Tomkins, J. K. Brody and M. Hamermesh. *Phys. Rev.*, **82**, 406–21 (*May* 1, 1951).

Helium isotope shift measurements previously reported have been extended and the He^3 hyperfine structure partially resolved. The h.f.s. of the ^3S levels is inverted, indicating a negative nuclear magnetic moment as expected. The splitting of the 2^3S level is 0·221 $\pm$ 0·005 cm^{-1}, while higher ^3S levels have a splitting of about 0·216 cm^{-1}, agreeing exactly with the expected values. The observed h.f.s. agrees very well with that calculated by taking into account the perturbations of neighbouring fine structure levels. The stronger h.f.s. components of transitions to the ^3P and ^3D levels are not resolved, but the structure must be considered in evaluating the isotope shifts. By including contributions from reduced mass and coupling effects, it is found that the predicted and observed shifts differ by $\sim 0{\cdot}1$ cm^{-1} in the sense that the He^3 ^3S and ^3D terms are higher and the ^1S and ^1D terms lower than expected, with respect to the ^3P and ^1P levels. The differences for S levels show an approximately linear decrease with term value T of $\sim -2{\cdot}2\times10^{-6}T$. In addition, the trend of the differences for successive D series members indicates an increase in the repulsion of the ^3D and ^1D terms near the crossing at $n = 8$ owing to the fact that the He^3 ^3D h.f.s. is larger than the He^4 ^3D fine structure. The results suggest that the Hughes–Eckart coupling terms for the 2^3P and 2^1P levels are too low, by about 12 and 20%, respectively, when calculated with one-electron wave functions.

A.

535.332 : 537.525.8

5252. Recombination and the helium afterglow spectrum. D. R. Bates. Letter in *Phys. Rev.*, **82**, 103 (*April* 1, 1951).

Discusses and explains the absence of a line spectrum in the helium afterglow, on the basis of 3-body collisions.

J. D. Craggs

535.337/.338

5253. Study of the emission spectrum of argon at high pressures. S. Weniger and R. Herman. *C.R. Acad. Sci., Paris*, **232**, 951–2 (*March* 5, 1951) *In French.*

Variations in the intensities of the continuum stretching from 2 000 to 9 800 Å, and of A I and A II lines are noted.

R. F. Barrow

535.338 : 535.33.03

5254. The excitation of HCO, C_2 and CH bands in flame spectra. A. G. GAYDON AND H. G. WOLFHARD. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 310–11 (*March*, 1951).

A criticism of mechanisms of formation and excitation suggested by Herman, Hornbeck and Laidler [Abstr. 1723 (1951)]. A. G. GAYDON

535.338 : 539.153

Spin–spin interaction. *See Abstr.* 5673

535.338.332

5255. Fundamental research in atomic spectra. W. F. MEGGERS. *J. Opt. Soc. Amer.*, **41**, 143–8 (*March*, 1951).

The discovery, refinement and quantum interpretation of atomic energy levels has been the principal goal of fundamental research in atomic spectra during the past quarter century. Analyses of the fine structure of spectra have revealed the electronic structures and the ionization potentials of atoms and ions; studies of hyperfine structure of spectral lines have yielded data on the mechanical, magnetic, and electric-quadrupole moments of atomic nuclei. This paper rates the fine structure analyses of 504 spectra of 84 chemical elements, and quotes the nuclear moments for 184 isotopic species. A.

535.338.332 : 537.228.5

5256. On the stark effect of the line H_β. T. SAKURAI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 167–79 (*Feb.*, 1950).

The rest line of the canal-ray was separated spectroscopically from the Doppler lines and its Stark effect was observed. The rest line was much sharper than the line given by the transverse observation of the canal-ray and the Stark components were well resolved in the field of 11 570 V/cm. The intensities of the Stark pattern obtained were found to be in fair agreement with "dynamische Intensitäten," except those of the components ± 4 and ± 6. These discrepancies were explained by the fact that the mean free time of the residual gas atoms was not extremely great compared with the mean lives of their excited states. The observed asymmetries of the displacements are in excellent accordance with the theoretical values computed by Ryde. It was found, however, that the displacement was about 0·4% greater in every individual component than that which is theoretically expected. The most probable value of the coefficient of the first-order Stark effect was given as $(6{\cdot}433 \pm 0{\cdot}012) \times 10^{-5}$. A.

535.338.4

5257. C_2 (Swan) bands in krypton. G. K. MEHTA AND V. RAJESWARI. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 210–11 (*Feb.*, 1951).

See also Abstr. 2551 (1951).

535.338.4

5258. Isotope effect in hydrocarbon flame bands. W. M. VAIDYA. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 428–30 (*April*, 1951).

535.338.4

5259. Emission band of the Cd_2 molecule at λ 2212. W. R. S. GARTON. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 430–1 (*April*, 1951).

535.338.4 : 535.343

5260. Fundamental research in molecular spectra. R. W. B. PEARSE. *J. Opt. Soc. Amer.*, **41**, 148–52 (*March*, 1951).

A review of the present position with regard to the spectra of diatomic and simple polyatomic molecules. Since in many cases the conditions existing in the astrophysical source differ greatly from those existing in laboratory sources, some of the features of these spectra have proved difficult to identify. It appears likely that valuable information regarding physical and chemical processes may be gleaned from behaviour under these conditions which cannot be duplicated in the laboratory. A.

535.338.4 : 539.132

5261. Calculation of relative transition probabilities for first negative bands of N_2^+. G. STEPHENSON. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 209–10 (*Feb.*, 1951).

Calculations have been made of the relative transition probabilities between the lower vibrational levels for $B^2\Sigma_u^+ - X^2\Sigma_g^+$ in N_2^+. The results agree closely with those calculated by Bates [Abstr. 2839 (1949)] using Morse functions and with the experimental values. R. F. BARROW

535.338.4 : 539.132

5262. Intensity distribution of the first negative ($B^2\Sigma \rightarrow X^2\Sigma$) band system of N_2^+. R. G. TURNER AND R. W. NICHOLLS. Letter in *Phys. Rev.*, **82**, 290 (*April* 15, 1951).

Calculated transition probabilities for some fifty bands are given. R. F. BARROW

535.338.42

5263. The vibration-rotation bands of OH in the photographic infrared. G. A. HORNBECK AND R. C. HERMAN. Letter in *J. Chem. Phys.*, **19**, 512 (*April*, 1951).

Emission of the 4–0, 5–1 and 6–2 bands from the outer cone of the oxy-acetylene flame is reported. R. F. BARROW

535.339

5264. A simple conversion of the Beckman IR-2 into a monochromator. R. ANTHONY. Note in *Rev. Sci. Instrum.*, **22**, 338–9 (*May*, 1951).

535.339

5265. The principle and adjustment of the Hilger–Müller double monochromator. C. BILLINGTON AND D. A. DAVIES. *J. Opt. Soc. Amer.*, **41**, 329–31 (*May*, 1951).

A mathematical treatment of the principle of the Hilger–Müller double monochromator is offered. On this basis, a sequence of adjustments is deduced for achieving correct focus. With the aid of a figure defining the symbols used, it should be possible to focus the instrument without appreciating the mathematical conceptions involved. A.

535.341 : 548.0

5266. The transmittance of cesium bromide crystals. E. K. PLYLER AND F. P. PHELPS. Letter in *J. Opt. Soc. Amer.*, **41**, 209–10 (*March*, 1951).

535.343–14

5267. Microwave spectroscopy. R. HONERJÄGER. *Naturwissenschaften*, **38** (*No.* 2) 34–9 (1951) *In German.*

A review of the experimental methods and applications of microwave spectroscopy to gases and of the Lamb–Retherford effect in the H spectra. D. H. WHIFFEN

535.343–15

5268. Relative *f*-values for lines of Cr I. A. J. HILL AND R. B. KING. *J. Opt. Soc. Amer.*, **41**, 315–21 (*May*, 1951).

Relative *gf*- and *f*-values for 430 lines in the spectrum of Cr I have been measured in electric furnace absorption spectra. The lines range in wavelength from 3 192 Å to 7 462 Å, and in low excitation potential from 0·00 to 3·45 V. A comparison is made between observed and theoretical intensities of lines in 5 multiplets. A.

535.343.2–15

5269. The fundamental vibrations and crystal structure of H_2S and D_2S. J. B. LOHMAN, F. P. REDING AND D. F. HORNIG. Letter in *J. Chem. Phys.*, **19**, 252–3 (*Feb.*, 1951).

The spectrum of crystalline H_2S at 68°K agrees with the vibrational assignment of Allen, Cross and King [Abstr. 1744 (1951)]. J. JACOBS

535.343.2–15

5270. Spectroscopy in infrared by reflection and its use for highly absorbing substances. I. SIMON. *J. Opt. Soc. Amer.*, **41**, 336–45 (*May*, 1951).

If the measurements are performed at two different angles of incidence, the two optical constants, namely, the refractive index n and the index of absorption κ of the studied substance can be obtained. A graphical method for obtaining n and κ from the measured reflecting powers is described and due corrections for the apparatus polarization are given. An alternative method for obtaining the optical constants from a single set of measurements at normal incidence is indicated for a case of a simple resonance band. This method is based on the impedance concept of the reflecting medium. Experimental arrangement for reflection measurements, using a standard i.r. spectrometer, is described. Examples of measured reflecting powers and optical constants derived from them are given for the cases of quartz, mica and liquid CCl_4. A.

535.343.2–15 : 539.133

5271. Infra-red spectra and structure of fibrous proteins. E. J. AMBROSE AND A. ELLIOTT. *Proc. Roy. Soc. A*, **206**, 206–19 (*April* 10, 1951).

The spectra of silk suture, porcupine quill, elephant hair, swan quill, gelatine and rat-tail tendon have been observed with polarized infrared radiation. The first four materials give spectra which show that they contain both extended (β) and folded (α) peptide chains. A band at about 4 600 cm^{-1} is assigned to a C=O combination frequency, whose dichroism indicates the direction of the transition moment for a C=O deformation mode. Gelatine and collagen give similar spectra, and are different from either α or β proteins or polypeptides. A method of folding a peptide chain, based on a suggestion of Huggins, is given which accounts for the known infrared and X-ray spectra of collagen and gelatine. A.

535.343.2–15 : 548.7

The use of polarized infra-red radiation in the study of crystal structure. *See Abstr.* 5909

535.343.2–34 : 548.7

5272. A new type of short wavelength absorption band in alkali halides containing color centers. C. J. DELBECQ, P. PRINGSHEIM AND P. YUSTER. *J. Chem. Phys.*, **19**, 574–7 (*May*, 1951).

Photo-chemically and additively coloured KI crystals exhibit absorption bands in the ultra-violet which do not have the characteristic properties of *V*-bands. An interpretation of the origin of these bands is proposed. A.

535.343.3–15

5273. The infrared spectra of mesitylene complexes. G. C. PIMENTEL, G. JURA AND L. GROTZ. Letter in *J. Chem. Phys.*, **19**, 513–14 (*April*, 1951).

Details of the spectra of liquid mesitylene, mesitylene saturated with I and a 0·02M solution of Mg laurate in mesitylene are given. The complexes appear to have a lower symmetry, in agreement with Rundle and Goring [*J. Amer. Chem. Soc.*, **72**, 5337 (*Nov.*, 1950)]. R. F. BARROW

535.343.3–15

5274. The near infrared absorption spectrum of liquid water. J. A. CURCIO AND C. C. PETTY. *J. Opt. Soc. Amer.*, **41**, 302–4 (*May*, 1951).

The near i.r. absorption spectrum of liquid water at 20°C has been reinvestigated using a PbS cell detector system. The total spectral range investigated was from 0·70 to 2·50 μ. A curve is included which shows 5 prominent absorption bands at 0·76, 0·97, 1·19, 1·45 and 1·94 μ; and a table gives experimental results of water absorption at 20°C. A.

535.343.3–15 : 539.133

5275. The characteristic infra-red frequencies of the carboxylic acid group. M. ST. C. FLETT. *J. Chem. Soc.*, 962–7 (*April*, 1951).

The infrared spectra of 60 carboxylic acids, with widely varying structures, have been measured between 700 and 4 000 cm^{-1}, to improve the certainty with which a carboxylic acid group can be distinguished from other acidic groups by infrared spectroscopy. The reliability of five bands as tests for the presence of the carboxy-group has been assessed. For three of these bands it has proved possible to determine the effect of structural changes, such as the introduction of substituents and conjugation with double bonds and ring systems, on precise frequency of the band. No general relationship between the spectra of acids and their dissociation constants was discovered. A.

535.343.32–15

5276. Infrared spectrum of aneurin and cocarboxylase. H. LENORMANT AND M. HÉRISSON. *C.R. Acad. Sci., Paris*, **232**, 815–16 (*Feb.* 26, 1951) *In French.*

Gives the spectra between 2·7 and 7·5 μ in solutions with *p*H 10, 6 and 2. They are very similar for both substances. C. TURNER

535.343.32–15

5277. The spectra and structure of iron carbonyls. II. Iron tetracarbonyl. R. K. SHELINE. *J. Amer. Chem. Soc.*, **73,** 1615–18 (*April*, 1951).

Abstr. 4843 (1950), previous part. The infrared absorption spectra of iron tetracarbonyl were obtained with NaCl prism optics over the region 2–15 μ and the visible and ultraviolet absorption spectra of iron carbonyl, iron enneacarbonyl and iron tetracarbonyl were taken from 2 180–7 000 Å. Narrowing of the extremely intense band beyond 2 180 Å in $Fe(CO)_5$ when it is cooled so that the tail of this band does not appear in the visible is proposed as the explanation for the disappearance of colour in $Fe(CO)_5$ when it is cooled to −196°. A D_{2d} structure for iron carbonyl is strongly indicated by a diamagnetic susceptibility, by X-ray diffraction studies, by the presence of a ketone-like carbonyl band at 1 833 cm^{-1}, and by the existence at 2 835 Å of a forbidden electronic transition found in aldehydes and ketones. A.

535.343.32–15 : 539.133

5278. Intensities of bands due to free and bonded hydroxyl groups in the 3-micron region. S. A. FRANCIS. Letter in *J. Chem. Phys.*, **19,** 505–6 (*April*, 1951).

The theoretical value of the ratio of dipole moment matrix elements is incorrect if integrated absorption intensities are considered. J. JACOBS

535.343.4–14

5279. Microwave spectrum of methyl mercaptan. F. K. HURD AND W. D. HERSHBERGER. Letter in *Phys. Rev.*, **82,** 95–6 (*April* 1, 1951).

55 lines listed 19 900–25 900 Mc/s. D. H. WHIFFEN

535.343.4–14

5280. An empirical formula for the microwave spectrum of ammonia. C. C. COSTAIN. Letter in *Phys. Rev.*, **82,** 108 (*April* 1, 1951).

535.343.4–14 : 539.133

5281. Microwave collision diameters and associated quadrupole moments. R. M. HILL AND W. V. SMITH. Letter in *Phys. Rev.*, **82,** 451 (*May* 1, 1951).

Experimental molecular quadrupole moments for benzene ($1{\cdot}3\times10^{-16}$ cm^2), ethylene ($0{\cdot}48\times10^{-16}$ cm^2), etc., from the pressure broadening of the (3, 3) inversion line of NH_3. D. H. WHIFFEN

535.343.4–14 : 539.152.1

5282. The spin of O^{18}. S. L. MILLER, A. JAVAN AND C. H. TOWNES. Letter in *Phys. Rev.*, **82,** 454 (*May* 1, 1951).

The microwave spectrum of $O^{16}O^{18}$ and $O^{18}O^{18}$ near 59 000 Mc/s shows the spin of O^{18} to be zero on account of the absence of hyperfine structure and the absence of alternate rotational levels for $O^{18}O^{18}$. D. H. WHIFFEN

535.343.4–15

5283. Absorption spectra of water vapor and carbon dioxide in the region of 2·7 microns. W. S. BENEDICT AND E. K. PLYLER. *J. Res. Nat. Bur. Stand., Wash.*, **46,** 246–65 (*March*, 1951).

The absorption due to atmospheric H_2O and CO_2 in the region of 2·7 μ has been remeasured under higher resolution than previously reported. By using a 15 000-line grating and a PbS photoconductive cell, some 450 lines have been measured between 2·43 and 2·87 μ. A rotational analysis may be given for nearly all the lines. A.

535.343.4–15

5284. The infrared spectra of HOCl and DOCl. K. HEDBERG AND R. M. BADGER. Letter in *J. Chem. Phys.*, **19,** 508–9 (*April*, 1951).

With a partial rotational analysis 4 force constants were evaluated. The OH and OD stretching constants differ appreciably. J. JACOBS

535.343.4–15

5285. The infrared spectra of Cl_2O and ClO_2. K. HEDBERG. Letter in *J. Chem. Phys.*, **19,** 509 (*April*, 1951).

The 1 245 cm^{-1} band is now attributed to the ν_2 bending vibration of HOCl. J. JACOBS

535.343.4–15

5286. The infrared spectrum of sulfur hexafluoride. R. T. LAGEMANN AND E. A. JONES. *J. Chem. Phys.*, **19,** 534–6 (*May*, 1951).

The i.r. absorption spectrum of gaseous SF_6 has been investigated from 2 to 25 μ with prism spectrometers of high resolution. The frequencies of the i.r. active fundamentals found by earlier workers have been confirmed with the exception of one, formerly found at 965 cm^{-1}, which is shown to be at 940 cm^{-1}. However, the remainder of the spectrum differs considerably from previous work. With the aid of the Raman data, the observed spectrum has been interpreted in detail. A.

535.343.4–31 : 535.375.5

5287. Raman effect and ultraviolet absorption spectra of molybdenum and tungsten hexafluorides. K. N. TANNER AND A. B. F. DUNCAN. *J. Amer. Chem. Soc.*, **73,** 1164–7 (*March*, 1951).

The Raman effect for MoF_6 and WF_6 has been studied and three lines were found for each molecule. Two of the lines are weak and diffuse, and the third is strong, sharp and highly polarized. This result indicates octahedral structure for these molecules. If this symmetry is assumed, the Raman inactive frequencies can be calculated from force constants obtained from the Raman active frequencies. Exploratory studies have been made on the ultraviolet absorption spectra of these molecules. A strong absorption band has been found for each, with a centre probably around 1 850 Å for MoF_6 and about 1 750 Å for WF_6. This appears to represent the first allowed electronic transition. An interesting banded structure was found for this transition in MoF_6. A.

535.343.4–32

5288. Ultraviolet absorption spectrum of gaseous hydrogen fluoride. E. SAFARY, J. ROMAND AND B. VODAR. Letter in *J. Chem. Phys.*, **19,** 379–80 (*March*, 1951).

Extinction coefficients for the continuum in the region 55 000 to 67 000 cm^{-1} at four temperatures between 16·5° and 165°C are given. R. F. BARROW

535.343.4–32

5289. The absorption spectrum of keten in the far ultra-violet. W. C. PRICE, J. P. TEEGAN AND A. D. WALSH. *J. Chem. Soc.*, 920–6 (*April*, 1951).

535.347

5290. Researches on dichroism of planar complexes. I. S. YAMADA. *J. Amer. Chem. Soc.*, **73,** 1182–4 (*March*, 1951).

Dichroism of microscopic crystals of compounds with planar complex ions was measured in the region from visible to near-ultraviolet by the microscopic method. It was found that dichroism of planar complexes can be classified into the tetrahalogeno-type and the tetracyano-type. These are discussed from the standpoints of the theory of absorption spectra for metallic compounds and the new co-ordination theory of valency, which had been proposed by Tsuchida. General regularities in the dichroism of planar complexes were deduced. A.

535.347

5291. Researches on dichroism of planar complexes. II. The color and the structure of $[Pt(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][PtBr_4]$. S. YAMADA. *J. Amer. Chem. Soc.*, **73,** 1579–80 (*April*, 1951).

Dichroism of crystals of "Magnus salt type compounds," $[Pt(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][PtBr_4]$, was measured in the visible and near-ultraviolet region by the microscopic method. From comparative consideration of measurement results with dichroism of K_2PtCl_4, $K_2PtBr_4 \cdot 2H_2O$ and $Pt(NH_3)_4Cl_2 \cdot H_2O$ (preceding Abstr.), the colour of Magnus' salt type compounds was discussed. In these compounds, there exists direct interaction between Pt ions of planar complex ions PtX_4^{--} (X : halogens) and $Pt(NH_3)_4^{++}$, which gives rise to remarkable bathochromic effect. This interaction is supposed due to mutual disturbance between electronic clouds of d-electrons which spread above and below the central Pt ions. A.

535.37

5292. The quenching of anthracene fluorescence. E. J. BOWEN AND W. S. METCALF. *Proc. Roy. Soc. A*, **206,** 437–47 (*May* 22, 1951).

The quenching of the fluorescence excited by light of wavelength 3 650 Å by oxygen, sulphur dioxide, and by carbon tetrabromide, has been investigated both in the gaseous state and in paraffin solutions of viscosities from 0·003 to 1·9 poises. In the gaseous state quenching occurs on nearly every collision. The quenching in dilute solution is shown to be controlled (*a*) by static quenching whereby light is absorbed by anthracene molecules contiguous to quencher molecules, and (*b*) by the diffusion together of excited molecules and quencher molecules. The former process is of greater importance in solutions of high viscosity. The latter predominates at more usual viscosities, and is found to be more nearly proportional to the diffusion coefficient of anthracene than to the fluidity of the solvent. Measured diffusional quenching constants are in good agreement with calculated values. The magnitudes of static constants indicate that in solutions containing anthracene and a quenching substance the two solutes are not randomly distributed but tend to associate with one another. A.

535.371

5293. Quenching of phosphorescence. I. A. BECKER. **III. Quantitative.** A. BECKER AND F. BECKER. *Z. Phys.*, **125** (*No.* 7–10) 475–86; (*No.* 11–12) 694–706 (1949) *In German.*

Part I describes studies on the increase of quenching by irradiation, using ZnSCu. It is found that the increase depends only on the total irradiation and not on the time and is linked with a decrease of excitability. It depends on the material but not on the intensity of emission. The rate of growth of phosphorescence is unaffected by the quenching effect, but the rate of decay increases with it. The quenching effect lasts a long time after irradiation. The spectral distribution of the infrared quenching shows two regions from the end of the red to 1·8 μ with an inert region in between at about 1·4 μ. For part II see Abstr. 1398 (1949). Part III is an attempt to deduce general laws, from experimental observations, of the quantitative effects. J. EWLES

535.371

5294. Note on the fluorescence yield of argon. D. L. DEXTER AND W. W. BEEMAN. Letter in *Phys. Rev.*, **81,** 456 (*Feb.* 1, 1951).

It is believed that the fluorescence yield can be calculated accurately for A by using experimental data of Parratt [*Phys. Rev.*, **56,** 295–7 (*Aug.* 15, 1939)] and wave functions determined by solving Fock's equations. The agreement between the results of the simple calculation described in this paper and the experimental data indicates that the internal conversion coefficient is very close to 0·88 for A and to 0·89 for Cl. J. EWLES

535.371

5295. Luminescence of dyestuffs in solid solution in plexiglass. E. LAFITTE. *C.R. Acad. Sci., Paris,* **232,** 812–14 (*Feb.* 26, 1951) *In French.*

The objections to other solvents are given. The present method consists in allowing a dilute solution of dyestuff in monochlorhydrin of glycol to diffuse into plexiglass. Two blocks so treated are put together so as to form an internal homogeneous layer in a transparent cube whose outer faces are subsequently polished. Classical methods are used to measure the fundamental polarization. The numbers all lie between 0·39 and 0·46. This is contrasted with the spread of numbers obtained when other solvents are used. The results indicate the strong anisotropy of the oscillators responsible for luminescence. J. EWLES

535.371

5296. A test procedure for simultaneous determination of resolving power and image surface of fluorographic cameras. E. INGELSTAM AND P. J. LINDBERG. *J. Opt. Soc. Amer.*, **41,** 346–8 (*May*, 1951).

A test screen containing as a new element "tilted test plates" has been constructed, the image of which in a fluorographic camera gives data for a comprehensive study of its optical properties. It is intended for use in the routine testing of cameras in hospitals and in the development of optical systems. A.

535.371

5297. Directional properties of single crystal of anthracene regarding fluorescence phenomena. S. C. GANGULY AND N. K. CHAUDHURI. *J. Chem. Phys.*, **19,** 617–18 (*May*, 1951).

The polarization of fluorescent radiation of single crystal of anthracene has been measured and this

measurement has been utilized to determine the nature and orientation of oscillators. From this measurement it has been found that the oscillators are linear oscillators and their direction is independent of the direction of the electric vector of the incident light vibration. They make an angle of 33° with the *b* axis of the crystal. A.

535.371 : 537.311.32

5298. The variation of luminescence and electrical conductivity of CdS crystals with alpha-particle irradiation. I. BROSER AND R. WARMINSKY. *Z. Naturforsch.*, **5a**, 85–102 (*Feb.*, 1951) *In German.*

The change of luminescence and electrical conductivity due to alpha particles and to photons in various CdS crystals is investigated after prolonged exposure to Po alpha particles. Results show that alpha particles produce empty electron trapping states in the crystals in which electrons can make non-radiative transitions to the ground state. The results can be interpreted by use of the Riehl–Schön band model and provide new information on the differences between particle and photon excitation of crystals.

G. F. J. GARLICK

535.375.5

5299. A vibrational analysis of the fluorescence spectrum of formaldehyde. J. C. D. BRAND. Letter in *J. Chem. Phys.*, **19**, 377–8 (*March*, 1951).

The ultraviolet fluorescence spectra of HCHO and DCHO are analysed. They are consistent with the infra-red spectra and confirm the identification of the 1 166 cm^{-1} and 938 cm^{-1} with the vibration of HCHO and DCHO respectively. J. EWLES

535.375.5

5300. Calculation of the Raman shift in vacuum. A. OPLER. *J. Opt. Soc. Amer.*, **41**, 349–50 (*May*, 1951).

A correction table is given to simplify conversion of the wavelengths of Raman lines observed as angstroms (in air) to wave numbers (in vacuum). Two more elaborate tables for direct conversion are described. All tables were calculated by punched card machines using the Barrell and Sears dispersion formula. A.

535.375.5

5301. The Raman spectra of hexamethylcyclotrisiloxane and octamethylcyclotetrasiloxane. H. MURATA. Letter in *J. Chem. Phys.*, **19**, 659–60 (*May*, 1951).

535.375.54

5302. On the Raman spectra of naphthalene at low temperature. A. K. RAY. *Indian J. Phys.*, **23**, 539–44 (*Dec.*, 1950).

The Raman spectra of a homogeneous crystalline mass of naphthalene have been studied for 3 different temperatures, e.g. 30°C, −100°C and −180°C, using a spectrograph having a dispersion of 11·8 Å/mm in the region of 4 046 Å. A new Raman line at 95 cm^{-1} has been observed in the case of the crystal at 30°C besides the other 5 lines in the l.f. region reported by previous authors. The line 75 cm^{-1}, which is broad at 30°C, becomes sharper at lower temperatures and all the 6 lines shift away from the Rayleigh line with the lowering of temperature. A.

535.375.54

5303. The excitation spectra of some tungstates. A. J. OSZY. Letter in *J. Opt. Soc. Amer.*, **41**, 57–8 (*Jan.*, 1951).

While a single Gaussian curve fits the emission spectra of $CdWO_4$ and of $ZnWO_4$ a sum of several is necessary for the excitation curves. This suggests that the activator ion may be raised to one of several excitation levels but drops to the lowest excited level before emission takes place. J. EWLES

535.375.54

5304. On the origin of low frequency Raman lines in organic crystals. S. C. SIRKAR. Letter in *J. Chem. Phys.*, **19**, 256 (*Feb.*, 1951).

Assumption of rotatory oscillation of the benzene molecule about one of its axes, or of linear oscillation of two molecules against each other explains the low frequency Raman lines recorded for the crystalline state better than rotatory oscillation of the molecule about its three axes [Abstr. 8641 (1950)]. W. R. ANGUS

535.375.54

5305. Photometry of Raman spectra of crystals. II. P. S. NARAYANAN. *Proc. Indian Acad. Sci., A*, **33**, 97–9 (*Feb.*, 1951).

Abstr. 4683 (1949) Pt. I. The relative intensities of the Stokes and anti-Stokes components of the most intense and high frequency shift Raman lines in calcite, gypsum and barytes have been studied by a spectrophotometric method and the results confirm the dependence of the intensity of a Raman line on the fourth power of the emission frequency. A.

535.375.54

5306. Theoretical low temperature spectra of the thallium activated potassium chloride phosphor. F. E. WILLIAMS. Letter in *Phys. Rev.*, **82**, 281 (*April* 15, 1951).

The computed absorption spectra at 4°K, 80°K and 298°K are shown. It is predicted that reducing the temperature below 80°K will not appreciably narrow the absorption band. J. EWLES

535.39

5307. Refraction and reflection of a sideways limited light wave on the plane surface of separation between two media in the neighbourhood of the grazing angle of total reflection. K. ARTMANN. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 270–84 (1951) *In German.*

A mathematical treatment. The transmitted wave in the region of partial reflection is first discussed. This is followed by the study of the reflected wave in the region of total reflection with a high number of reflections. The wave equations are solved by means of superposition of plane waves. An explicit integration is not required since their character approaches that of the Sommerfeld formula for diffraction on a semi-plane. S. TOLANSKY

535.39

5308. The reflection of a sideways limited light wave at a thin medium at some distance from the grazing angle of total reflection. K. ARTMANN. *Ann. Phys. Lpz.*, **8** (*No.* 5–8) 285–90 (1951) *In German.*

It is shown that the wave equation can only be satisfied by using a complex amplitude term. It is shown that the conclusion of Schaefer and Fragstein

[Abstr. 4804 (1950)] can only be confirmed for non-absorbing media at total reflection. For other cases, including partial reflection at non-absorbing media and reflection at absorbing media, their conclusions are modified if a complex amplitude term is introduced.

S. TOLANSKY

535.39 : 535.417

5309. Phase change of light on reflection at a mica-silver interface. E. EISNER. *Research, Lond.*, **4**, 183–5 (*April*, 1951).

A new method is described for the investigation of the phase change of light reflected on the mica side of a metallic film deposited on mica. The method is especially useful for the highly reflecting films used in multiple-beam interferometry. It consists in measuring the optical thickness of a mica sheet coated on both sides with the metal, cleaving the mica, and measuring the optical thicknesses of the two portions similarly. The difference between the sum of these and the optical thickness of the uncleaved mica is a measure of the phase change. The phase change for Ag is found as a function of wave number. A.

535.39 : 535.417

5310. Interference method for the measurement of the absolute phases in the study of absorbing media. R. FLEISCHMANN. *Z. Phys.*, **129** (*No.* 3) 275–84 (1951) *In German.*

Despite the importance of the absolute phase change which occurs with light passing through absorbing media (in particular metal films), no general method for determining this exists because it involves production of interference between beams of differing intensity when absorption is strong. Alternatively both sides of the layer often have contact with different optical media. The new technique proposed employs two coherent polarized light beams which can be brought to equal intensity without altering the phases and with these beams good interference fringes can be produced. If the intensity change required is measured then the absolute phase change can be calculated. The phase measurement can be obtained by 4 methods, namely, fringe shift, degree of ellipticity, intensity change and rotation of polarization.

S. TOLANSKY

535.39 : 535.417

5311. The determination of optical constants and film thickness of absorbing layers by means of measuring absolute phase changes. R. FLEISCHMANN AND H. SCHOPPER. *Z. Phys.*, **129** (*No.* 3) 285–99 (1951) *In German.*

By using the complex amplitude which is derived from phase and intensity measurements a new method can be developed for the simultaneous evaluation of the optical constants and the thickness of an absorbing layer in which internal multiple reflection is disregarded. The determination of opaque layers by optical methods has so far not been possible. The new method is applied to antimony sulphide and the values of the constants and thickness determined for various wavelengths in the visible regions of strong absorption. Thicknesses up to about $\lambda/3$ are studied. Because the material is transparent in the red, optical controls on the thickness can be made and the newer technique is confirmed as reliable. The method functions at normal incidence and is thus not affected by any anisotropy which might arise at other angles of incidence. The test is non-destructive, which is advantageous.

S. TOLANSKY

535.39 : 535.417

5312. The dependence on angle of incidence of the variation of phase change on reflection at silver. G. DÖRNENBURG AND R. FLEISCHMANN. *Z. Phys.*, **129** (*No.* 3) 300–6 (1951) *In German.*

The phase displacements are measured with a Jamin interferometer for the reflections glass-silver and air-silver over a wide angular range. The two beams are brought to equal intensity by polarization methods. The phase change is separately determined for the two directions of polarization. Some variation is found in different samples and this is attributed to surface films whose thickness and optical properties are evaluated by the method of Drude. S. TOLANSKY

535.39 : 535.6

5313. On the colour of reflection-reducing films. S. BUCH. *Z. wiss. Photogr.*, **45** (*No.* 10–12) 212–15 (1950) *In German.*

The relationship between the colour, when viewed in reflected light, of single-layer films deposited on glass supports and the refractive indices of the film material and the glass is briefly discussed. It is shown that the usual blue colour of bloomed lenses and prisms is not essential, particularly when multiple-layer films are used. S. WEINTROUB

535.39 : 539.23

5314. Numerical tables for the phase and intensity measurements of metallic films. I. K. ISHIGURO. *J. Phys. Soc. Japan*, **6**, 1–4 (*Jan.–Feb.*, 1951).

Values for the film thickness, the refractive index and the extinction coefficient are derived in terms of the transmission and reflection coefficients and the phase shift at angles of incidence of 0 and 70°. The range of the data is suitable for Ag-films. The required values are obtained by interpolation. Seven figs. are given. R. A. WEALE

535.39 : 539.23

5315. Numerical tables for the phase and intensity measurements of metallic film. II. K. ISHIGURO. *J. Phys. Soc. Japan*, **6**, 5–9 (*Jan.–Feb.*, 1951).

Tables giving numerical values for the functions derived in the previous paper are presented.

R. A. WEALE

535.39 : 539.23

5316. Determination of the optical constants of Ag films from the measurements of intensity and phase change. I. K. ISHIGURO AND G. KUWAHARA. *J. Phys. Soc. Japan*, **6**, 71–5 (*March–April*, 1951).

Phase changes are measured with a double slit interferometer, formerly described, and the optical properties for λ 5 900 determined by a photocell method. Electron diffraction patterns showed that the Ag films were disoriented particles at least > 30 Å in size. Phase shifts, transmissions, reflections and absorptions are recorded. Film thickness was estimated from weight of Ag evaporated, and measurements are reported from zero thickness to 400 Å.

For films thicker than 100 Å transmission phase change is positive, i.e. phase velocity of light in Ag exceeds that in air. Values for n and k are given, the values found agreeing with those for solid Ag for thickness over 200 Å. Below this n increases to more than 1 and k diminishes. The measured optical thickness agrees with the weight thickness down to 100 Å, but below this the optical thickness seems to approach a constant value of 50 Å even when weight thickness is only 10 Å (a few atom layers).

S. TOLANSKY

535.39 : 539.23

5317. Determination of the optical constants of Ag films from the measurements of intensity and phase change. II. K. ISHIGURO AND G. KUWAHARA. *J. Phys. Soc. Japan*, **6**, 76–8 (*March–April*, 1951).

The method of calculation adopted to obtain the results in paper I (preceding Abstr.) is presented both for thick and thin films. The validity of film uniformity is discussed. S. TOLANSKY

535.417

5318. The light distribution functions of multiple-layers and their applications. H. SCHRÖDER. *Z. angew. Phys.*, **2** (*No.* 2) 53–66 (1951) *In German.*

A general expression is derived in the form of a series. For the practical purpose of "blooming" the quadratic terms suffice. Various types of reduction of reflectivity are discussed. Narrow band-pass interference filters and the case of $\lambda/2$ cryolite sandwiched between 7 layers of $\lambda/4$ ZnS is discussed in detail. Systems with periodic alternations of layers are discussed. The calculations are applicable to absorbing media as well as to dielectrics. Simplifications are discussed in the case of periodic alternating layers. Beam-splitters are considered, especially those with no wavelength dependence. Interference polarizers are discussed, in which at the Brewster angle one beam is extinguished, but the other is strengthened by interference layers.

S. TOLANSKY

535.417

5319. The compound Fabry–Perot interferometer. D. H. RANK, R. P. RUTH AND K. L. V. SLUIS. *J. Opt. Soc. Amer.*, **41**, 351–3 (*May*, 1951).

A description of the operation of the compound etalon with identical spacings is given. Conditions are given for the superposition of ghosts produced by reflections between etalons on the main pattern. The methods used in achievement of accurate register of the interference patterns for all wavelengths are described. Examples are given contrasting the use of the compound interferometer external and internal to the spectrograph. A.

535.42

5320. The axial aberrations of zone plates. G. TORALDO DI FRANCIA. *Atti Fond. "Giorgio Ronchi,"* **6**, 3–7 (*Feb.*, 1951) *In Italian.*

A Soret zone plate may be considered as an ordinary optical instrument with an axis of symmetry. The chromatic and spherical aberrations on axis are computed for the diffracted wave. Both aberrations are shown to be much greater than in conventional optical systems. R. W. FISH

535.42

5321. The correction of defects due to diffraction. A. BLANC-LAPIERRE, M. PERROT AND P. DUMONTET. *C.R. Acad. Sci., Paris*, **232**, 1342–4 (*April* 2, 1951) *In French.*

A mathematical transformation of the diffraction pattern at infinity of an object at infinity is given. By choice of transformation the usual image defects due to diffraction can be reduced and the image rendered more like the object. A method of achieving this in practice is indicated. R. W. FISH

535.42

5322. A correction to the treatment of Fresnel diffraction. C. L. ANDREWS. *Amer. J. Phys.*, **19**, 280–4 (*May*, 1951).

Measurements of the diffraction pattern of microwaves near circular apertures reveal the quantitative correctness of Kirchhoff's obliquity factor. According to Kirchhoff's equation, the amplitude from a zone as the zone number increases without bound is not zero but half the amplitude from the central zone. By Young's theory of the diffraction pattern of the aperture, the positions of maximum and minimum intensity may be predicted not only in the Fresnel region but also behind the aperture and in the plane of the aperture itself. A.

535.421

5323. A slit phase contrast apparatus with modified phase plates for the examination of optical gratings and other objects with variations in one dimension. E. INGELSTAM. *Ark. Fys.*, **3**, *Paper* 2, 35–9 (1951).

Polarized light from an entrance slit is diffracted by the grating, and a given line is arranged to fall on a reflection phase strip. This latter consists of a metallized glass surface from which a narrow strip of the metal film has been removed. Light falls on the glass surface so revealed at the Brewsterian angle. By means of a second sheet of polaroid the relative amplitudes of the direct and diffracted light may be varied. A phase-contrast image of the grating is formed by a lens placed in the light beam reflected from the phase plate. The apparatus makes possible the study of periodic grating errors. The grating may be either mounted or unmounted. H. H. HOPKINS

535.421

5324. A study by phase contrast of the errors in the rulings of gratings. A.-M. CAMUS, M. FRANÇON, E. INGELSTAM AND A. MARÉCHAL. *Rev. Opt.* (*Théor. Instrum.*) **30**, 121–37 (*March*, 1951) *In French.*

The relationship between the amplitude of the diffracted light in the "ghosts" and the periodic errors of position in the rulings of a grating is determined by the use of the Fourier transformation. A phase-contrast method enables these errors of position to be studied directly. This method, which is easy to operate, is shown to be the most sensitive available and it is proposed that it should be used to control the ruling of high-quality gratings. R. W. FISH

535.421

5325. An efficient grating mount. N. A. FINKELSTEIN. *J. Opt. Soc. Amer.*, **41**, 179–82 (*March*, 1951).

By solving, simultaneously, the law of specular reflection and the grating diffraction law, it is possible

to determine the conditions for working on the blaze, that wavelength region for which the direction of diffracted flux coincides with that of specularly reflected flux. It can be shown that by rotation of the grating in combination with rotation and translation of a plane mirror from which the diffracted flux is reflected, the grating may be used on the blaze over wide wavelength regions in a particular order. Design equations are derived and examples of visible and infrared applications are given. The system is particularly applicable to infrared spectrometry where ordinarily several gratings are required to cover the desired wavelength range. A.

535.422

5326. On improving the precision of longitudinal location of an optical image. B. DOSSIER, P. JACQUINOT, A. MARÉCHAL AND G. PIEUCHARD. Letter in *J. Phys. Radium*, **12**, 142 (*Feb.*, 1951) *In French.*

A non-uniform distribution of amplitude over a pupil modifies not only the diffraction pattern but also its rate of change along the axis. The image can be located more precisely by suitable modifications of the distribution to give the maximum rate of change. For a point object and a circular aperture, the maximum rate of change is found with a small central aperture and a marginal annulus of equal area. For a line object, three slit apertures equally spaced, with the central slit twice the width of the outer slits, gives the maximum rate of change. R. W. FISH

535.43

5327. The constants of Rayleigh scattering in gases and liquids. G. DE VAUCOULEURS. *Ann. Phys., Paris*, **6**, 213–324 (*March–April*, 1951) *In French.*

Gives experimental details and the theoretical discussion on classical electromagnetic theory of the determination of the depolarization and diffusion factors of the light scattered by argon, air, ethyl cloride, ether and benzene. Hg lines were used and measurements made by a special photoelectric densitometer. The results lead to a value for Avogadro's number in close agreement with the accepted value. It is concluded that the generalized Rayleigh–Cabannes formula applies to gases whether perfect or not, and whether isotropic or not. The calculated value from current theory of the diffusion coeff. of the liquids does not agree with the observed value, but can be made to do so by small adjustments to the theory. N. CORCORAN

535.43

5328. Concerning certain anomalous small angle diffraction effects. G. H. VINEYARD. Letter in *Phys. Rev.*, **82**, 453 (*May* 1, 1951).

Discusses the negative experimental results [Abstr. 3466 (1951)] for the scatter of radiation at the faces of a parallelopiped which, according to the Born approximation, should extend to large angles when the incident beam is parallel to one face. This is said to arise because the Born approximation is valid only when the phase shift through the scattering medium is small. R. W. FISH

535.43 : 548.7

5329. Thermal scattering of light in birefringent crystals. V. CHANDRASEKHARAN. *Curr. Sci.*, **19**, 371–2 (*Dec.*, 1950).

Considers the effect of birefringence of the crystal in which thermal scattering of light (Brillouin scattering) is taking place, and shows that instead of the 3 pairs of Doppler components which normally occur, 12 pairs are to be expected when the crystal is birefringent. The magnitudes of the shifts expected when 2 537 Å is scattered in calcite are calculated, and shown to lie within the limits of measurement. A. C. MENZIES

535.434

5330. Scattering of light by colloids. A. J. A. VAN DER WYK. *Arch. Sci.*, 3 (*No.* 6) 419–44 (1950) *In French.*

It is shown on classical interference theory that the intensity scattered by a particle of dimensions $< \lambda/30$ is proportional to the square of the vol. whatever the shape of the particle. For larger particles it is shown that there will always be values of λ for which no light is scattered in any particular direction. N. CORCORAN

535.434 : 541.18 : 541.135

5331. The effect of gegen ions on the light scattering by solutions of colloidal electrolytes. T. M. DOSCHER AND K. J. MYSELS. Letter in *J. Chem. Phys.*, **19**, 254–5 (*Feb.*, 1951).

An extension of the fluctuation theory of light scattering including the requirement of electroneutrality leads to the same conclusions as were reached by Hermans [Abstr. 1682 (1950)]. R. F. BARROW

535.435

5332. Study of the light scattered by a solution of anisotropic [uniform, thin and randomly oriented] rod-like particles. P. HORN, H. BENOIT AND G. OSTER. *C.R. Acad. Sci., Paris*, **232**, 810–12 (*Feb.* 26, 1951) *In French.*

Expressions are developed for scattered intensities of different polarizations as a function of angle (θ) to the direction of incidence, when the polarizabilities along (α) and perpendicular to (β) the rod axis are different. Curves show how the ratio of scattered intensities for $\theta = 45°$ and 135° varies with the ratio (R) of rod length to wavelength. Curves are given for R up to 1 and for anisotropies $[\delta = (\alpha - \beta)/(\alpha + 2\beta)]$ of 1, 0·5, 0·2 and 0. For $\delta = 0$ the results agree with earlier calculations of Debye [see Zimm, Stein and Doty, *Polym. Bull.*, **1**, 90 (1945)]. G. F. LOTHIAN

535.435

5333. Scattering of light by solutions of strong electrolytes; influence of the variation of the coefficient of activity with concentration. R. LOCHET. *C.R. Acad. Sci., Paris*, **232**, 1084–6 (*March* 12, 1951).

The variation of the Rayleigh coefficient with concentration has been derived for strong electrolytes. Practical results are given for zinc sulphate in both aqueous and acid solutions. R. W. FISH

535.514

5334. Polarization of light scattered by spherical particles. F. PERRIN AND A. ABRAGAM. *J. Phys. Radium*, **12**, 69–73 (*Feb.*, 1951) *In French.*

From a consideration of the parameters of Stokes for the case of an isotropic, turbid, non-symmetrical medium, which possesses rotatory power, the 10 coefficients that determine the intensity and state of

polarization of the light scattered in a given direction are given by 5 equations, provided the scattering is produced by a suspension of identical spheres. Only one of these equations exists if the spheres differ in size or in optical properties. In the absence of rotatory power, there are only 4 coefficients for a suspension of any spherical particles; if the particles are identical, or small in comparison to the wavelength, these coefficients are connected by one equation. Starting from the formulae of Mie and Debye (1908) (1909), the 4 scattering coefficients are calculated for a transparent sphere. The possibilities of the determination of the dimensions of particles in suspension by the complete study of the polarization of the scattered light for incident light of any polarization whatsoever are discussed.

H. G. JERRARD

535.514 : 532.7

5335. On the polarization of Rayleigh scattering as an aid to determine molecular configuration in liquids. D. H. RANK. Letter in *J. Chem. Phys.*, **19**, 511 (*April*, 1951).

The dependence of the degree of polarization of the Rayleigh scattering of liquids on the spherical symmetry of the molecule or associated complex is discussed.

W. R. ANGUS

535.543

5336. On sensitive colour. H. KUBOTA. *J. Phys. Soc. Japan*, **6**, 67–8 (*Jan.–Feb.*, 1951).

For a thin crystal between crossed Nicols the hue of the sensitive colour decreases in wavelength as the colour temperature of the incident white light rises. The relation is shown on a C.I.E. chromaticity diagram.

J. W. T. WALSH

535.64

5337. The calculation and exposition of the concentration and luminance diagrams for practical purposes. E. HELLMIG. *Z. wiss. Photogr.*, **45** (*No.* 7–9) 129–39 (1950) *In German.*

Using 3 Agfa pigments (Agfacolorpositivfarbstoffe), the author determined the concentration and luminance curves within the C.I.E. chromaticity chart. Diagrams and graphical methods facilitating the computations are given. The influence of the spectral transmissivities of the pigments on the nature of the curves is discussed.

R. A. WEALE

535.64

5338. Experiments towards establishing a colour system based on equal sensory differences. M. RICHTER. *Z. wiss. Photogr.*, **45** (*No.* 7–9) 139–62 (1950) *In German.*

This admittedly preliminary report contains a description of the experimental procedure used to establish a new colour atlas. Curves of equal saturation in the C.I.E. chromaticity chart are compared with others obtained from an empirical formula, and points realized in the atlas are indicated there. Defects of the Ostwald system are revealed. Graphs and diagrams are presented.

R. A. WEALE

535.65 : 518.3

5339. Nomograms for the transformations between the CIE and MacAdam's u, v chromaticity charts. E. HELLMIG. *Z. wiss. Photogr.*, **45** (*No.* 10–12) 216–27 (1950) *In German.*

Nomograms are provided to transform the two systems, the accuracy being 0·001. Four diagrams are given.

R. A. WEALE

535.8 : 531.717.85

5340. Precision alignment in daylight. C. FRANK AND A. C. S. VAN HEEL. Letter in *J. Opt. Soc. Amer.*, **41**, 277 (*April*, 1951).

The authors report a simple modification to a precision sighting device to enable it to be used in full sunlight.

R. W. FISH

535.8 : 535.24

5341. Equalization of the light intensity in the image plane in wide-angle objectives. M. NAGEL. *Optik*, **8** (*No.* 1–2) 24–30 (1951) *In German.*

In a 10 cm $F/5{\cdot}6$ Topogon the decrease of light intensity at 45° angle of field was found to be 75% according to the $(\text{cosine})^4$ law. The effect of oblique incidence on the photographic plate was found to make this decrease nearly 90%. The photometry was done photographically using a step wedge for comparison. To overcome this unequal intensity a glass plate was used as a base for a rhodium film of radially increasing transparency. This is placed with the metal film in contact with the photographic plate, thereby equalizing the exposure between the centre and the edge of the plate.

H. H. HOPKINS

535.822.9

5342. A new method of interference microscopy. W. KRUG AND E. LAU. *Technik*, **6**, 122–9 (*March*, 1951) *In German.*

The principles of microscope interferometry are reviewed. A critical description is given of the Linnik and Zeiss–Linnik type instruments. A new interference microscope is described. This has a beam splitter between the objective and the object. For reflection interferometry it is a modified form of Michelson interferometer, but because a long working distance is needed, only low powers can be employed. Fringe contours of razor blade edges and of steel balls are illustrated. The apparatus is modified for examination of internal bores of big diameter. For transmission systems a modified Mach–Zehnder interference arrangement is described. Applications to growing crystals, surface topography and biological specimens are described. Total magnifications up to $\times 300$ are recorded. Only two beam interferometry is involved.

S. TOLANSKY

535.824.2

5343. The design of reflecting microscope objectives. W. H. STEEL. *Aust. J. Sci. Res. A*, **4**, 1–11 (*March*, 1951).

The general theory is developed and the exact solutions obtained for the design of reflecting microscope objectives having two or three concentric spherical surfaces. It is shown that the only serious optical defect of reflecting objectives, low contrast due to the high obstruction ratio, can be satisfactorily controlled in three-mirror systems. Non-concentric objectives are discussed, but in practice prove to be difficult to adjust.

A.

535.824.2

5344. Computed aberrations of spherical Schwarzschild reflecting microscope objectives. D. S. GREY. *J. Opt. Soc. Amer.*, **41**, 183–92 (*March*, 1951).

A microscope objective with (small) central

obstruction of aperture and small wave-front deformation has a loss of amplitude at the centre of the Airy disk which may be expressed in terms of losses due to spherical aberration, coma and central obstruction. These losses are essentially independent; the net loss is the sum of the separate losses. Data are presented from which these losses for Schwarzschild spherical mirror systems of high initial magnification may be computed. It is shown that for visible or ultraviolet light and for numerical apertures greater than about 0·5, the net loss of central amplitude becomes excessive unless the object field is restricted to an extraordinarily small diameter. The numerical aperture at which such restriction of the field is necessary may be increased if the initial magnification is made small, e.g. about 8×, as is possible and convenient for infrared microspectroscopy. A.

HEAT 536

536.2 : 536.46

5345. Contribution to the graphical study of thermally variable systems. J. JACQ. *C.R. Acad. Sci., Paris*, **232**, 1292–4 (*March* 28, 1951) *In French.*

The graphical method of integration, due to Binder and Schmidt, for the calculation of thermally variable systems is extended to the case, most often encountered in practice, where the given condition is the flow from the source of heat, which may or may not depend upon the interior temperature. F. E. HOARE

536.21

5346. Stefan-like problems. G. W. EVANS II, E. ISAACSON AND J. K. L. MACDONALD. *Quart. Appl. Math.*, **8**, 312–19 (*Oct.*, 1950).

The recrystallization of an infinite metal slab at the critical point is treated as a problem in heat conduction. Opposite faces of the slab are supposed at different fixed temperatures so that a surface of recrystallization moves forward through the slab. The equation for the heat balance across this surface is deduced and solved as a Taylor's series for two special cases and more generally by means of a Laplace transformation. E. H. DOCK

536.21

5347. A problem in heat conduction. J. V. GARWICK. *Forsvarets. Forskn. Inst. Arb.*, **2**, 1–17 (1948–49).

Mathematical. An infinitely extended wall composed of two parts, the one close to the heat source a bad conductor, and the other a good conductor with its outer layer in contact with the air or a cooling liquid, is considered. The temperature of the outer layer as a function of time is determined. The Laplace transformation and the Mittag–Leffler series development are used in the solution of the differential equations. S. WEINTROUB

536.21

5348. Solution of a heat flow problem. J. R. M. RADOK. *Aust. J. Sci. Res. A*, **4**, 12–15 (*March*, 1951).

Deals with the heat flow through a rectangle subject to the following boundary conditions: one end is completely insulated (without heat flux across it) and at the opposite end a constant temperature gradient is maintained; the remaining sides radiate into a medium which is at zero temperature. Initially the rectangle is at zero temperature. The problem is converted into a homogeneous one by considering a rectangle of twice the length with a uniformly distributed heat source along the centre line. The solution of this problem is effected by using particular solutions given by Carslaw and Jaeger. The problem considered is of interest in connection with the testing of heat-insulating materials. A.

536.21

5349. A problem in heat conduction. B. PODOLSKY. *J. Appl. Phys.*, **22**, 581–5 (*May*, 1951).

A steady-state temperature distribution is found for the case of a periodically varying point source of heat, immersed in a homogeneous isotropic infinitely extended fluid, moving with a constant velocity. The phase velocity of the generated temperature wave is discussed. If the phase velocity in a stationary medium is V_0, and the fluid velocity $v > V_0$, the phase velocity in a moving medium is given by $V = v[1 + \frac{1}{2}(V_0/v)^8 - (5/8)(V_0/v)^1 + \ldots]$. For practical cases one can usually assume $V = v$, with an error of less than 0·1%, even when V_0 is as large as 20% of v. A.

536.212 : 537.311.32

5350. Notes on the electrical and thermal conductivities of graphite and amorphous carbon. S. MIZUSHIMA AND J. OKADA. Letter in *Phys. Rev.*, **82**, 94–5 (*April* 1, 1951).

The electrical conductivity of polycrystalline graphite is shown to be characteristic of a pure metal, whereas amorphous carbon such as pitch coke acts as a semiconductor of low activation energy. The large differences between thermal conductivities of graphite and amorphous carbon are explained in terms of Kittel's explanation [Abstr. 4721 (1949)] for silica and fused quartz. C. A. HOGARTH

536.23 : 533.7

5351. On the heat conduction of gas mixtures. H. BOCK. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 134–55 (1950) *In German.*

Introducing an "effective concentration" $C_i' = (C_i/\sqrt{M_i})/(\Sigma C_i/\sqrt{M_i})$, it is shown that the Eucken relation $\lambda = KC_v\eta$ can be applied to gas mixtures, if the viscosity η of one gas mixture of components of molar concentrations C_i is related to the thermal conductivity λ of another gas mixture, the "effective concentrations" C_i' of which are equal to the C_i of the first mixture (M_i = molecular weights). For the specific heat C_v and the Eucken constant K the arithmetic mean values based on the concentrations of the first mixtures are used. In the second part an expression is given for the thermal conductivity λ_c of a binary mixture in terms of that of the components λ_1 and λ_2: $1/\lambda_c = C_1'^2/\lambda_1 + C_2'^2/\lambda_2 + 2C_1'C_2'/\lambda_{12}$. Here $\lambda_{12} = P\sqrt{(\lambda_1\lambda_2)} = p_1p_2\sqrt{(\lambda_1\lambda_2)}$, where P is a constant of the order of magnitude 1 which is specific for each pair of components, but can in many cases be expressed as the product of two factors, p_1 p_2, attributed to the individual components. These relations, which are arrived at from model considerations, are in good agreement with experimental data. H. LONDON

536.423

5352. On drying by evaporation in vacuo. L. DUNOYER. *C.R. Acad. Sci., Paris*, **232**, 1080–2 (*March* 12, 1951) *In French.*

A theoretical study of the rate of evaporation of water contained in an evacuated vessel immersed in a constant temperature bath. It is shown that the water soon reaches a limiting temperature fixed by the geometry and thermal conductivity of the vessel and that the most important factor in dehydration speed is the temperature of the surrounding bath. Numerical examples are given. L. G. CARPENTER

536.423.15 : 536.48

5353. The vapor pressures of hydrogen, deuterium and tritium up to three atmospheres. E. R. GRILLY. *J. Amer. Chem. Soc.*, **73**, 843–6 (*Feb.*, 1951).

Triple points and heats of vaporization and of sublimation have been derived from the vapour pressures. A.

536.423.4

5354. Time lag in the self-nucleation of a supersaturated vapor. R. F. PROBSTEIN. *J. Chem. Phys.*, **19**, 619–26 (*May*, 1951).

By the obtaining of an approximate solution to the non-steady Becker–Döring equation for the self-nucleation of a supersaturated vapour, an attempt has been made to determine whether the time lag associated with the approach to the steady state rate of formation of condensation nuclei could account for the discrepancies between theory and experiment. Also considered is the time lag arising from the heating of the nuclei due to bombardment by molecules of the condensing phase as well as the time lag resulting from an accommodation coefficient for the liquid nuclei different from unity. Calculations of the self-nucleation of water vapour in air and N in air have been carried out. A.

536.424 : 537.323

Allotropic transformation of titanium. *See Abstr.* 5427

536.46

5355. Investigation of turbulent flames. B. KARLOVITZ, D. W. DENNISTON, JR. AND F. E. WELLS. *J. Chem. Phys.*, **19**, 541–7 (*May*, 1951).

A new theory of turbulent burning velocity has been developed. Comparison of the predictions of the theory with turbulent burning-velocity measurements has led to recognition that the turbulent flame itself generates additional turbulence. A theory has been formulated to explain the production of turbulence by the turbulent flame, which permits calculation of the intensity of flame generated turbulence. A comparison of calculated maximum turbulence intensity values with the turbulence intensities that correspond to the measured turbulent burning-velocity data supports this theory. A.

536.46 : 536.5

5356. A method for the determination of flame temperature from emission in the ultraviolet OH band. J. A. CURCIO, H. S. STEWART AND C. C. PETTY. *J. Opt. Soc. Amer.*, **41**, 173–9 (*March*, 1951).

A new method has been developed involving measurement of radiation, emitted by flames, in a narrow wavelength interval within the ultraviolet OH emission band. The mean value of flame emissivity within the wavelength interval is evaluated by measurement of mean flame transmission for a continuous spectrum source. The method requires that the wavelength interval studied be so narrow that the emission of the source used for transmission measurement and that of a blackbody at flame temperature both be approximately constant over the interval. The method has been tested on steady flames over temperature ranges from 2 000°K to 3 000°K and excellent agreement obtained with Na line reversal measurements. The time resolution was 0·10 msec and the accuracy in temperature measurement about 40°K in the range 2 000°K to 3 000°K. The method was calibrated by means of Na line reversal although it is easily adaptable to absolute calibration. A.

536.46 : 541.126

5357. Flame propagation. IV. Correlation of maximum fundamental flame velocity with hydrocarbon structure. R. R. HIBBARD AND B. PINKEL. *J. Amer. Chem. Soc.*, **73**, 1622–5 (*April*, 1951).

Abstr. 3493 (1951), part III. This maximum velocity appears to be a function of the concentrations of the various types of carbon–hydrogen bonds in the inflammable mixture. Maximum flame velocities can be calculated from an equation of the type: flame velocity $= N_A K_A + N_B K_C + N_C K_C \ldots$ where N_A, N_B, $N_C \ldots$ are the concentrations of the various types of C–H bonds and K_A, K_B, $K_C \ldots$ are empirically derived flame speed coefficients. Maximum flame velocities have been calculated for 34 hydrocarbons and compared with experimentally observed values. The average difference between calculated and observed flame velocity is less than 2% if one hydrocarbon is omitted from the average and the derived coefficients line up in approximately the order expected from other chemical considerations. A.

536.48

5358. On the mechano-caloric effect in liquid helium II. S. NAKAJIMA AND M. SHIMIZU. *Progr. Theor. Phys.*, **5**, 1010–13 (*Nov.–Dec.*, 1950).

A discussion of the part played in the 2-fluid model by Tisza's relation $\rho_n/\rho = s/s_\lambda$. R. B. DINGLE

536.48

5359. Solidification of He^3. D. W. OSBORNE, B. M. ABRAHAM AND B. WEINSTOCK. Letter in *Phys. Rev.*, **82**, 263 (*April* 15, 1951).

Describes experimental results for the melting curve of He^3 between 1·02°K and 1·51°K.

R. B. DINGLE

536.48

5360. The remarkable properties of helium. G. J. VAN DEN BERG. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 8) 51 *pp.* (1950) *In Flemish.*

Review article. 145 references. H. LONDON

536.48

5361. On the explosion of air-rectifying apparatus. II. Y. NOMURA AND E. KANDA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 229–32 (*April*, 1950).

In continuation of an investigation of hazards in the production of liquid O_2 [see Abstr. 7958 (1950)]

experiments have been carried out to determine the explosion risk of the following reactions (*a*) between C_2H_2 and liquid air through which an electric discharge has been passed, (*b*) between C_2H_4 and O_3, (*c*) between NO and O_3. Each of these reactions was shown to constitute an explosion hazard at liquid-air temps. The hazard appears to lie mainly in the presence of O_3. An attempt was made to discover O_3 in the liquid O_2 from an air-rectification plant; although the evidence suggests the presence of a minute amount of O_3 it is not regarded as conclusive. A. SCHOFIELD

536.48

5362. A small gas-cooled cryostat for temperatures between 4°K and 14°K. L. C. JACKSON AND H. PRESTON-THOMAS. *J. Sci. Instrum.*, **28**, 99–101 (*April*, 1951).

A simple addition to a Linde He liquefier is described by which temperatures in the range of 4–14°K can be produced. The heat influx is balanced by desorption of He gas from charcoal. A temperature constancy of ±0·001 deg. can be maintained for periods up to 1½ hr by manual control. A brief description of the He liquefier is also given. A.

536.48

5363. A small helium liquefier of the expansion type. A. VAN ITTERBEEK AND L. DE GREVE. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 10) 3–6 (1950).

536.48 : 536.632

5364. The specific heat of liquid helium at temperatures between 0·6° and 1·6°K. R. A. HULL, K. R. WILKINSON AND J. WILKS. *Proc. Phys. Soc., Lond. A*, **64**, 379–88 (*April*, 1951).

A detailed account is given of experiments. Below 1·4° the specific heat may be expressed as $C = 0{\cdot}024T^{6{\cdot}2}$ cal/g/deg. Some implications of this result are briefly discussed. A.

536.521

5365. An attempt to a photographic calibration of a tungsten ribbon lamp. N. HANSSON. *Ark. Astron.*, **1**, *Paper* 21, 223–47 (1951).

Gives experimental details, including photographic processing, for the determination (from density of photographic plate) of temperature of a lamp at different currents. The results agreed within 10° with the manufacturers' values over the range 1 850–2 710°C. An appendix gives the emissivity of W at temperatures from 1 200 to 2 800°C and wavelengths from 3 600 to 9 000 Å. N. CORCORAN

536.521

5366. A two-colour infra-red radiation pyrometer. A. F. GIBSON. *J. Sci. Instrum.*, **23**, 153–5 (*May*, 1951).

The ratio of the radiated energy in two wavelength bands received from a hot body is a measure of the body's surface temperature. As only a ratio is involved the measurement is independent of the emissivity of the body if this does not vary with wavelength over the used range, the distance of the body from the source, time of exposure, etc. The pyrometer described employs the above principle, a PbS photoconductive cell being used for radiation detection. Temperatures down to 200°C may be measured with adequate accuracy. A.

536.521 : 537.312.9

5367. The photoelectric determination of high temperatures. G. RIGHINI. *Atti Fond. "Giorgio Ronchi,"* **6**, 8–13 (*Feb.*, 1951) *In Italian.*

In optical pyrometry the effective wavelength varies with temperature. This is not so in pseudomonochromatic photoelectric systems. The optical bandwidth of the systems was best for blue, green and red filters ($< 0{\cdot}075\ \mu$) and less satisfactory for yellow and orange ($> 0{\cdot}100\ \mu$). The effective wavelengths are: 4 570 Å (blue), 5 200 Å (green), 5 630 Å (yellow), 5 830 Å (orange), 6 270 Å (red). The statistical dispersion is almost constant for all colours (medium: ±0·016). The method of measurement is described and particular attention paid to the relationship of the blue-red radiations for high, and the green-red radiations for low, temperatures. For a linearly responding system photocell-galvanometer the ratio of the two luminosities will be proportional to the readings on the galvanometer scale. Medium absolute deviation is 0·003. Although photoelectric pyrometry is somewhat less accurate than optical pyrometry, its advantage is that the readings need not be taken by experts as only galvanometer deflections are to be read. W. SUMMER

536.631

5368. On the anomalous specific heat of lead titanate. G. SHIRANE AND E. SAWAGUCHI. Letter in *Phys. Rev.*, **81**, 458–9 (*Feb.* 1, 1951).

The specific heat/temperature curve for lead titanate shows a sharp peak at 490°C—the temperature at which anomalies of permittivity and lattice spacing have been observed for this material. E. RUSHTON

536.632

5369. Heat capacity of liquid mercury between 0° and 450°C; calculation of certain thermodynamic properties of the saturated liquid and vapor. T. B. DOUGLAS, A. F. BALL AND D. G. GINNINGS. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 334–48 (*April*, 1951).

The enthalpy of liquid Hg was measured from 0° to 450°C by the "drop" method. These and other precise published data were used to calculate a number of thermodynamic properties of liquid and gaseous Hg at the vapour pressures from the triple point, −38·88°, to +500°C. The entropy calculated from data on the vapour and liquid was compared with that derived from published low-temperature heat-capacity data for the solid. The calculated values of vapour pressure, also using data on the vapour and liquid, were found to agree over a wide temperature range with certain published experimental values when independently derived gas-imperfection and published temperature-scale corrections were applied. A.

536.652 : 539.1

5370. On the latent heat of fusion and the hole theory. N. R. MUKHERJEE. Letter in *J. Chem. Phys.*, **19**, 502–3 (*April*, 1951).

Formulae are deduced, based on the hole theory, which allow the latent heat of fusion to be calculated. T. C. TOYE

THERMODYNAMICS 536.7/.8

536.7

5371. The thermo-mechanics of transport phenomena. J. E. VERSHAFFELT. *J. Phys. Radium*, **12**, 93–8 (*Feb.*, 1951) *In French.*

A concise account of the author's thermo-mechanical theory of transport phenomena based on the application of the principle of superposition. [Abstr. 217, 1720 (1949), 3136, 5793, 5850, 6665, 7257 (1950)].

F. E. HOARE

536.7

5372. On the use of curve differentials in thermodynamics. F. H. CRAWFORD. *Amer. J. Phys.*, **19**, 284–9 (*May*, 1951).

The question of an appropriate and precise statement of the first law of thermodynamics suitable for infinitesimal reversible changes is approached through a suitable integral form. This latter expresses the work done on and the heat added to the system in terms of "curve" (line) integrals along a specified curve of change, C. A.

536.75

5373. Methods of estimating the entropies of solid compounds. W. M. LATIMER. *J. Amer. Chem. Soc.*, **73**, 1480–1 (*April*, 1951).

By taking into account the effects of mass, ionic size and ionic charge, tables have been prepared for the positive and negative constituents of solid inorganic compounds which enable one to make estimates of the entropies of such compounds. A.

536.75 : 530.162

5374. The communal entropy of dense systems. J. A. POPLE. *Phil. Mag.*, **42**, 459–67 (*May*, 1951).

An approximate method of calculating the communal entropy of an assembly of monatomic particles. The method of dealing with dense systems may be regarded as an extension of that used by Lennard-Jones and Devonshire in their theory of liquids and dense gases. The available volume is divided into cells and the communal free energy expressed in terms of a set of parameters related to the probability of two, three or more particles occupying a given cell simultaneously. Application to an assembly of rigid spheres leads to the conclusion that the communal entropy does not become appreciable until the available volume is over five times that of a close-packed assembly. This suggests that, for more accurate intermolecular potentials, the communal entropy is practically zero in the solid and liquid states, but that the extra terms in the free energy may have an appreciable effect on the calculated critical constants and vapour pressures. A.

536.75 : 539.13

5375. Entropy of crystalline benzene calculated from molecular data. I. ICHISHIMA AND S. MIZUSHIMA. Letter in *J. Chem. Phys.*, **19**, 388 (*March*, 1951).

Normal frequencies lie in a narrow strip near the optically active frequency. Entropy S (mol. data) agrees well with S (therm. data). J. JACOBS

536.75 : 539.13

5376. Numerical integration as a labor-saving device in the compilation of thermodynamic properties of polyatomic molecules. R. E. PENNINGTON AND K. A. KOBE. Letter in *J. Chem. Phys.*, **19**, 510–11 (*April*, 1951).

Entropy and enthalpy may be found by integrating C_p^0/T and C_p^0. A five-point Lagrangian formula yields sufficient accuracy with an interval of 100°K. A table of these Lagrangian coefficients is given.

S. MICHAELSON

536.79

5377. On the application of Nernst's principle to liquids. Y. ROCARD. Note in *Rev. Sci., Paris*, **88**, 113 (*April–June*, 1950) *In French.*

From the point of view of pure thermodynamics the theorem originally enunciated by Nernst, or in the modified form due to Planck, is a principle, but in statistical mechanics it is a theorem. The author considers the implications of this distinction in applying the principle to the liquid-vapour equilibrium of a monatomic substance. Erroneous deductions regarding critical pressures may be made in this way. In the case of reactions in liquids where the principle appears verified this is because an additive term in the entropy happens to be eliminated in calculating the chemical constant of the reaction. F. E. HOARE

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

5378. Lagrangian formulation of Flint's theory of electrons. E. ALFSEN. *C.R. Acad. Sci., Paris*, **232**, 699–701 (*Feb.* 19, 1951) *In French.*

It is shown that an energy-momentum tensor may be defined in terms of a Lagrangian in a space of five dimensions in a familiar way, and that Dirac's Lagrangian leads to an expression used by Flint [*Phil. Mag.*, **29**, 330 (1940)]. J. R. MADDOX

537.12 : 530.162

5379. A collective description of electron interactions. I. Magnetic interactions. D. BOHM AND D. PINES. *Phys. Rev.*, **82**, 625–34 (*June* 1, 1951).

A new approach to the treatment of the interactions in a collection of electrons is developed. The collective description is based on the organized behaviour produced by the interactions in an electron gas of high density; this results in oscillations of the system as a whole, the so-called "plasma oscillations". The collective description, in contrast to the usual individual particle description, describes in a natural way the long-range correlations in electron positions brought about by their mutual interaction. The transition is obtained by a suitable canonical transformation. The complete Hamiltonian for a collection of charges interacting with the transverse electromagnetic field is re-expressed as a sum of three terms. One involves the collective field coordinates and expresses the degree of excitation of organized oscillations. The others represent the kinetic energy of the electrons and the residual particle interaction,

which is not describable in terms of the organized oscillations, and corresponds to a screened inter-particle force of short range. Both a classical and a quantum-mechanical treatment are given, and the criteria for the validity of the collective description are discussed. A.

537.13

5380. Evidence for the formation of positronium in gases. M. Deutsch. Letter in *Phys. Rev.*, **82,** 455 (*May* 1, 1951).

Time delays between emission of a gamma-ray by Na^{22} and the appearance of an annihilation quantum are interpreted as due to formation of a bound electron-positron system. Supporting evidence is obtained from the change of delay curves for positrons stopping in different gases. J. H. FREMLIN

537.133

5381. The measurement of e/M by cyclotron resonance. H. Sommer, H. A. Thomas and J. A. Hipple. *Phys. Rev.*, **82,** 697–702 (*June* 1, 1951).

The cyclotron resonance frequency of the proton has been measured using a new method. By measuring the spin precessional frequency of the proton in the same magnetic field, the proton magnetic moment in nuclear magnetons has been determined as $\mu_p = 2{\cdot}79276 \pm 0{\cdot}00006$. In combination with other data this result can be used directly to determine the charge-to-mass ratio of the proton $e/M_p = 9\,579{\cdot}4_2 \pm 0{\cdot}3$ emu/g, the Faraday $F = 9\,652{\cdot}0_3 \pm 0{\cdot}3$ emu/g (physical scale), and the ratio of the proton mass to the electron mass $M_p/m_e = 1\,836{\cdot}12 \pm 0{\cdot}05$. A preliminary value for the $H_2 - D$ doublet is given. A.

537.133 : 537.122

5382. The ratio of proton and electron masses. F. Lenz. Letter in *Phys. Rev.*, **82,** 554 (*May* 15, 1951).

ELECTROSTATICS . DIELECTRICS 537.2

537.213 : 577.3

5383. Distribution of electrical potential in the particular case of the membrane of a living cell. A. Goudot. *C.R. Acad. Sci., Paris,* **232,** 802–4 (*Feb.* 26, 1951) *In French.*

Cells in living matter consist of large granules bound to simple ions, and possess a positively charged envelope with respect to the interior. A discussion of the membrane potential (ψm) is given to explain the positive polarization of living cells, and it found that $\psi m = \frac{\varepsilon}{D_0} \cdot \frac{1 - e^{-\chi r}}{r}$, where ε is the ionic charge, D_0 the dielectric constant, r the approximate membrane thickness, and $1/\chi = \sqrt{(D_0 kT/8\pi r\varepsilon^2)}$ obtained from the equation $\Delta\psi = \chi^2\psi$. H. H. HODGSON

537.224 : 621.3.011.4 : 621.319.4

5384. The capacitance of a parallel-plate condenser with an anisotropic dielectric cylinder in torsion between its plates. C. Mack. *Phil. Mag.*, **42,** 428–31 (*April,* 1951).

An abridged version of a paper published as a Memoir of the Shirley Institute, Manchester 20. The problem is of importance in estimating the accuracy of the capacitance method of measuring the irregularity of cotton yarn. The cylinder is regarded as having, in its untwisted state, one dielectric constant along its length, but a different, though axially symmetric, transverse value.

537.226.1

5385. The problem of the occurrence of ferroelectricity. G. A. Smolenskiĭ and N. V. Kozhevnikova. *Dokl. Akad. Nauk, SSSR,* **76** (No. 4) 519–22 (1951) *In Russian.*

Types of structure, lattice parameters at about 20–25° C and Curie temperatures are tabulated for 26 ferroelectrics, including $RbTaO_3$ and MoO_3 investigated by the authors. Ferroelectricity occurs in crystals whose oxygenous octahedra, located in a specific fashion, are fully or partially filled by cations derived from atoms with last orbit but one not filled and having the electronic construction of a noble gas, large charge and small ionic radius. Relative positioning of oxygenous octahedra is of utmost importance. It is anticipated that ferroelectricity will be found not only among compounds in which oxygen serves as anion but also among compounds with other anions. J. LUKASZEWICZ

537.226.1

5386. Theory of antiferroelectric crystals. C. Kittel. *Phys. Rev.*, **82,** 729–32 (*Juné* 1, 1951).

An antiferroelectric state is defined as one in which lines of ions in the crystal are spontaneously polarized, but with neighbouring lines polarized in antiparallel directions. In simple cubic lattices the antiferroelectric state is likely to be more stable than the ferroelectric state. The dielectric constant above and below the antiferroelectric Curie point is investigated for both 1st- and 2nd-order transitions. In either case the dielectric constant need not be very high; but if the transition is second order, ε is continuous across the Curie point. The antiferroelectric state will not be piezoelectric. The thermal anomaly near the Curie point will be of the same nature and magnitude as in ferroelectrics. A susceptibility variation of the form $C/(T + \theta)$ as found in Sr titanate is not indicative of antiferroelectricity, unlike the corresponding situation in antiferromagnetism. A.

537.226.2

5387. A new deduction formula for measuring the dielectric constant of powder dielectric. I. K. Kamiyoshi. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A,* **1,** 305–11 (*Oct.*, 1945).

From measurements made on eight materials in powder form, the formula:—

$$(\kappa_p - 1) = (0{\cdot}900\,p - 1)(\kappa - 1)$$

is given for deriving the dielectric constant, κ, of the material from the measured dielectric constant, κ_p, of the powder, p being the volume ratio.

E. RUSHTON

537.226.2

5388. A new deduction formula for determining the dielectric constant of powder dielectric. II. K. Kamiyoshi. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A,* **2,** 180–92 (*Feb.*, 1950).

In part I (preceding Abstr.) an empirical formula was given for determining the dielectric constant of

substances tested in the form of powders. A theoretical formula, derived from equations originally developed by Rayleigh, is now obtained and is found to be confirmed experimentally. E. RUSHTON

537.226.2

5389. X-ray investigation of barium titanate ferroelectricity. W. KÄNZIG. *Helv. Phys. Acta*, **24** (*No.* 2) 175–216 (1951) *In German.*

The transition of untwinned ferroelectric $BaTiO_3$-crystals from the cubic (unpolarized) phase into the tetragonal (polarized) phase has been investigated by measurements of the integrated reflections (00 *l*) and (0 *k* 0) as a function of temperature. Near the transition-point fluctuations diminish extinction. This effect leads to a sharp peak of the extinction-sensitive reflections. The changes of the mosaic-structure are discussed. The variation of the structure-factors with temperature could be determined for the high-order reflections (00 *l*). The Debye-factor behaves quite normally in the cubic phase. There is no evidence for a loosely bound Ti-ion. At and below the Curie-point variations of the structure-factors were observed which can be accounted for by a shift of the atomic positions together with anomalous variations of the thermal amplitudes. A discussion of the Lorentz internal field is given in terms of Slater's theory. A.

537.226.2

5390. Effects of mechanical pressures on the dielectric properties of polycrystalline barium-strontium titanate. G. SHIRANE AND K. SATO. *J. Phys. Soc. Japan*, **6**, 20–6 (*Jan.–Feb.*, 1951).

The influence of hydrostatic pressure and of compression both normal and parallel to the electrode surfaces is investigated for barium–strontium titanates, in particular on the Curie point and the permittivity in the cubic region. E. RUSHTON

537.226.2

5391. New ferroelectric tartrates. B. T. MATTHIAS AND J. K. HULM. Letter in *Phys. Rev.*, **82**, 108–9 (*April* 1, 1951).

Lithium ammonium tartrate and lithium thallium tartrate (each crystallizing with one molecule of water) are found to be ferroelectric. The upper Curie points are 98·5 and 10° K respectively and measurements down to 1·3°K show no lower Curie points. The directions with ferroelectric susceptibilities are *b* in the first salt and *a* in the second. It is suggested that, compared to Rochelle salt, the water molecules play a relatively unimportant role.

A. L. MACKAY

537.226.2

5392. The dielectric constant of formamide. G. R. LEADER. Note in *J. Amer. Chem. Soc.*, **73**, 856–7 (*Feb.*, 1951).

537.226.2

5393. Variation of dielectric constants of ionic crystals with pressure. D. A. A. S. NARAYANA RAO. Letter in *Phys. Rev.*, **82**, 118–19 (*April* 1, 1951).

Mott and Littleton's theory of the static dielectric constants is found to lead to an anomalous position. The variations of the dielectric constants of 4 alkali halides with pressure are calculated from data quoted by Mayburg [Abstr. 7973 (1950)] using the approach of Born and Meyer [*Handbuch der Physik*, **24/2**, 647 and 656 (1933)] and agree with those observed; but the variations found for Mott and Littleton's overlap factor disagree with Mayburg's calculations. A. L. MACKAY

537.226.2

5394. Dielectric properties of sodium and potassium niobates. B. T. MATTHIAS AND J. P. REMEIKA. *Phys. Rev.*, **82**, 727–9 (*June* 1, 1951).

Deals with evidence of ferroelectricity in $KNbO_3$ and $NaNbO_3$. Temperatures at which both materials undergo crystallographic changes and corresponding changes in dielectric constant and loss tangent are reported. Photographs of dielectric hysteresis loops and values of saturation polarization taken at various points over a temperature range are given for $KNbO_3$. A.

537.226.2 : 536.413 : 536.63

5395. Dielectric and thermal properties of barium lead titanates. S. NOMURA AND S. SAWADA. *J. Phys. Soc. Japan*, **6**, 36–9 (*Jan.–Feb.*, 1951).

The permittivity of Ba–Pb titanates is determined for various proportions of Pb titanate, and it is deduced that the Curie point for Pb titanate is about 560°C, the permittivity at room temperature being 100. The linear coefficient of expansion and specific heat are also determined. E. RUSHTON

537.226.2 : 536.48

5396. The dielectric properties of $BaTiO_3$ at low temperatures. W. J. MERZ. Letter in *Phys. Rev.*, **81**, 1064–5 (*March* 15, 1951).

The dielectric constant and loss of single-domain crystals is measured at audio frequencies and the hysteresis loop at 60 c/s from room temperature down to 4·2°K. The dielectric constant in the *c*-direction decreases linearly with temperature below the transition at 180°K down to 4·2°K, the dielectric loss stays small and constant, and the coercive field strength increases strongly below 90°K. The ferroelectric properties are thus retained down to 4·2°K in contrast to Rochelle salt. C. A. HOGARTH

537.226.3

5397. On the relaxation and association of polar chain molecules in the pure liquid. G. KLAGES AND G. KREMMLING. *Z. Naturforsch.*, **5a**, 675–82 (*Dec.*, 1950) *In German.*

Absorption measurements from 10–300 m for aliphatic chlorides and alcohols are briefly given and discussed. It is difficult to sort out the effects due to polar association, H bond formation, change of molecular shape, internal rotation, multiple relaxation times, etc. Cetyl alcohol shows hysteresis effects below its m.pt. D. H. WHIFFEN

537.228.1 : 548.7

5398. The piezoelectric constant of zinc-sulfide. B. D. SAKSENA. *Phys. Rev.*, **81**, 1012–15 (*March* 16, 1951).

This has been calculated in two ways. First, by regarding it as a purely ionic crystal and considering that all the atoms are equally effective in producing the moment; and second, by regarding it as a purely covalent crystal and considering only the nearest neighbours. In the former case, the result agrees completely with that obtained by Born and Bormann.

The moment produced in an homogeneous elastic deformation is considered to be $ze\Delta r$, where Δr is the variation of the distance between the S and Zn atoms on deformation and ze is the charge on the ions. The moments due to all the S atoms at a given distance from a Zn atom in the crystal are first found. Resolving these along the axes and summing, the piezoelectric equations of the crystal are obtained. Next, the moments due to various sets of S atoms are summed so as to obtain a quickly converging result, and from this the piezoelectric constant can be obtained. The piezoelectric constant for a purely covalent crystal (formal charge on Zn atom 2−, and on S atom 2+) is found to be $5{\cdot}4\times10^4$ and that for a purely ionic crystal (formal charge on Zn 2+ and on S atom 2−) $-15{\cdot}8\times10^4$. Since the observed value of the piezoelectric constant ($-4{\cdot}20\times10^4$) lies between these two extremes, it is seen that the crystal has 67% ionic character and a formal charge of 0·68 unit on Zn and −0·68 unit on S. A.

537.228.2

5399. Remarks on the theory of electrostriction in Onsager liquids. H. Falkenhagen and H. Jacob. *Ann. Phys. Lpz.*, **8** (*No.* 3–4) 105–8 (1950) *In German.*

By a thermodynamical approach to the theory of electrostriction involving the Clausius–Mosotti relation for non-polar liquids and Onsager's theory for polar liquids it is shown how the pressure coefficients of electrostriction may be calculated. Values of this coefficient and of the pressure difference Δp produced by a given field are calculated for a number of liquids.

T. C. TOYE

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311

5400. The theory of the shot and Johnson noise. H. Dänzer. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 176–86 (1950) *In German.*

A unified theory, based on Fourier integral representation, of the two types of noise is given, thus avoiding difficulties included in the original formulations of the theories. A. H. W. BECK

537.311.22 : 621.3.011.2

5401. The resistance of a rectangular metal plate with an internal electrode. S. D. Daymond. *Quart. J. Mech. Appl. Math.*, **4**, 23–8 (*March*, 1951).

A steady current enters the plate through a small circular electrode and flows out through an electrode which coincides with the rectangular boundary. The effective resistance is found from a harmonic function which is constant over each electrode. The appropriate function is expressible in Jacobian elliptic functions, but the δ-functions are used, as these are more suitable for numerical work. There are 4 parameters, and numerical values of the resistance are found for representative values of these parameters. A.

537.311.31 : 539.4.016

5402. Conductivity of cold-worked metals. R. Landauer. *Phys. Rev.*, **82**, 520–1 (*May* 15, 1951).

In the vicinity of an edge-type dislocation, the density of electrons, and therefore the width of the filled portion of the conduction band is not uniform. To keep the electrons in equilibrium, an electrostatic potential is required. The scattering caused by this potential is used to calculate the increased resistance of isotropically cold-worked Cu. A.

537.311.32

5403. The electrical conductivity of magnetite. H. Watanabe and N. Tsuya. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 29–34 (*Feb.*, 1950).

This was measured in the temperature range including the transformation temperature. Measurements of single crystals showed a marked jump of conductivity at that temperature. The variation of conductivity with applied magnetic field is also measured and the amount of it was not so large as expected by the theory which assumes the transformation to be that of spontaneous magnetization. Previous theories are criticized on the basis of the experimental results obtained. A.

537.311.33

5404. Formation of barrier layers in alloys by means of chemical compounds. S. G. Kalashnikov and L. N. Erastov. *J. Tech. Phys., USSR*, **21**, 129–34 (*Feb.*, 1951) *In Russian.*

According to Davydov's and Schottky's theories the explanation of the rectifying effect is to be found in the curvature of the energy zones of a semiconductor by a contact field. The direction of current passage must correspond to the metal with the lower work function, on which a negative potential is superimposed. This was demonstrated on suitable metals, i.e. Mg and Sb, and also on Zn. The intermetallic compounds of these metals, Mg_3Sb_2 and ZnSb, have high resistivity and may be obtained by welding. A. V. and A. F. Joffe's theory of solid rectifiers states that in the rectifying phenomenon the contact of two semiconductors of different character of semiconductivity (electronic and hole-semiconductivity) is essential. These propositions were confirmed on the said intermetallic compounds.

B. F. KRAUS

537.311.33

5405. Measurement of semiconductor impurity content. C. N. Klahr and L. P. Hunter. Letter in *Phys. Rev.*, **81**, 1059–60 (*March* 15, 1951).

Derives equations whereby the impurity content, effective mass and dielectric constant may be determined using results of measurements of the Hall coefficient and resistivity at a given temperature.

E. P. WOHLFARTH

537.311.33

5406. Resistivity and Hall constant of semiconductors. C. N. Klahr. Letter in *Phys. Rev.*, **82**, 109–10 (*April* 1, 1951).

A more general calculation than that of Jones [Abstr. 3527 (1951)] is performed, in which mean free paths due to lattice scattering, ionized impurity scattering, and non-ionized impurity scattering are involved. C. A. HOGARTH

537.311.33

5407. The variation with temperature of the electrical properties of a degenerate electronic semiconductor as exemplified by cadmium oxide. R. W. Wright. *Proc. Phys. Soc., Lond. A*, **64**, 350–62 (*April*, 1951).

Strong strip specimens were prepared from CdO

powder such that they possessed an electrical conductivity of the order of 300 $ohm^{-1}\,cm^{-1}$ at room temperature. Simultaneous measurements of the Hall constant R and the electrical conductivity σ were made throughout the temperature range 0–500°C, and the thermoelectric power dE/dT was measured immediately afterwards on the same specimen. The properties were found to resemble those of a metal: R was found to have a constant value independent of the temperature. dE/dT is approximately 60 μV/deg. C at room temperatures, whilst σ decreases with temperature, its value at 500°C being roughly half that at 0°C. The theory of degenerate semiconductors is developed, and since the values of R indicate that there is a constant number of free electrons in each specimen, this result is incorporated into the comparison of the theory with the experimental results. Satisfactory agreement is obtained between theory and experiment. Agreement is also obtained when the theory is compared with results obtained by another investigator for the thermoelectric power of CdO. The approximate form of the theory predicts that the thermoelectric power and the resistivity should be directly proportional to the absolute temperature. The experimental results are found to confirm this. CdO behaves as an excess degenerate semiconductor, with properties strongly resembling those of a metal. A.

537.311.33

5408. Infra red absorption and intrinsic semiconductivity of condensed aromatic systems. E. A. Kmetko. Letter in *Phys. Rev.*, **82,** 456 (*May* 1, 1951).

Studies of i.r. absorption spectra and semiconduction of charred cellophane films show qualitative agreement between absorption band position and activation energy for the semiconduction.

G. F. J. GARLICK

537.311.33 : 621.314.63

5409. Thermal instability of contact rectifiers: the effect of the constituent materials on the efficiency of a rectifying junction. E. Billig. *Proc. Phys. Soc., Lond. B,* **64,** 342–5 (*April,* 1951).

If due allowance is made for the lowering by the image force of the height of the potential barrier in contact rectifiers, current-voltage characteristics can be calculated which are in good agreement with observed characteristics. On application of a voltage in the blocking direction, electrons (or holes) pass over the barrier owing to their thermal energy, the number of successful passes, i.e. the leakage current, being exponentially dependent on temperature. As the applied voltage is increased and the barrier lowered, the power loss corresponding to the increased leakage current will eventually raise the temperature in the thin barrier layer sufficiently to increase the current in turn until the cooling arrangement provided cannot cope with the increased power loss and the rectifier becomes thermally unstable. The conditions for this instability to arise are investigated quantitatively. Amongst other parameters such as mode of operation, cooling, etc., the conductivity of the semiconductor, and in particular the height of the potential barrier, have a paramount effect on the maximum voltage that can be withstood. The simultaneous requirements for large resistivity and barrier height severely restrict the choice of materials which can be used for efficient rectifiers. A.

537.311.33 : 621.314.63

5410. The theory of direct-current characteristics of rectifiers. P. T. Landsberg. *Proc. Roy. Soc. A,* **206,** 463–77 (*May* 22, 1951).

It is shown how the image force can be taken into account very simply by making a minor improvement in the current theory of rectification. The equations obtained have been compared with experimental d.c. reverse characteristics of the Cu_2O, Se and Ge rectifiers, assuming in each case, first, that a Mott barrier is present, and, secondly, that a Schottky barrier is present. Agreement is satisfactory, the hypothesis of a Schottky barrier leading to a slightly better fit in all cases. As regards the numerical constants calculated from a fit of the experimental results, satisfactory values can be obtained if a Mott barrier is assumed. If a Schottky barrier is presupposed, the results for the Cu_2O and Se rectifier lead to very low values for the mobilities and high values for the impurity centre densities in the barrier region. This is discussed. The effect of the image force on the current carrier distribution is illustrated, and a general relation between the diffusion and diode theory established. A.

537.311.33 : 621.314.63

5411. Contributions to the theory of heterogeneous barrier layer rectifiers. P. T. Landsberg. *Proc. Roy. Soc. A,* **206,** 477–88 (*May* 22, 1951).

Assuming an arbitrary distribution of space charge in the barrier layer of a rectifier, the general form of the current-voltage relation has been derived on both diode and diffusion theory. A connection, valid for most barriers, between this characteristic and the capacitance-voltage curve has been pointed out, and it has been shown that the Sachs breakdown voltage can be deduced from the latter characteristic. The general relations have been applied to a barrier whose distribution of impurity centres is assumed to establish itself by a diffusion process. Its properties have been investigated, and it has been found that the shapes of the experimental d.c. characteristics (previous Abstr.), are in the same good agreement with the hypothesis of this barrier as they are with the hypothesis of a Schottky barrier. The difficulties regarding the constants of the rectifiers, as obtained from the experimental curves, are, however, greatly alleviated if the present barrier rather than Schottky's barrier is assumed. It has been shown that both barriers belong to a whole class of barrier layers whose d.c. and capacitance-voltage curves have the same shape as the corresponding curves for a Schottky barrier. A.

537.311.33 : 621.315.61

5412. Electron-bombardment conductivity of dielectric films. F. Ansbacher and W. Ehrenberg. *Proc. Phys. Soc., Lond. A,* **64,** 362–79 (*April,* 1951).

Films of some dielectrics become conductive under the influence of electron bombardment. This conductivity was investigated both for steady and for alternating bombardment in its dependence particularly on temperature, current density and the

potential difference across the dielectric. The gain, i.e. the ratio of current through the film to the bombarding current increases strongly with temperature. On arsenic sulphide films, the gain reaches 40 000. The effect is discussed in the light of theories of conduction in dielectrics and of recent work on allied subjects. A.

537.312.5

5413. Notes on the development and application of infra-red-sensitive galena, PbS, PbSe, and PbTe photocells. F. MICHELSSEN. *Optik*, **8** (*No.* 1–2) 75–6 (1951).

A brief historical review of both natural and synthetic infra-red sensitive Pb compounds is given. This account centres on the work done by the author, particularly on galena mesh cells (Bleiglanz–Netzzellen) and galena light funnel cells (Bleiglanz–Licht–Trichterzellen) which are semiconductors of the natural photoelectric PbS type. The mesh cells use as an anode a metal grid that makes contact under pressure with the crystal surface (photocathode), while the Trichterzellen (funnel cells) use a sharp-pointed triangular miniature funnel-like anode on the crystal surface. See also Abstr. 2696 (1951). W. SUMMER

537.312.5

5414. Infra-red photoconductivity of certain valence intermetallic compounds. J. G. N. BRAITHWAITE. *Proc. Phys. Soc., Lond. B*, **64**, 274–5 (*March*, 1951).

Various metal tellurides have been prepared (method is discussed) and their sensitivity spectra in the i.r. observed. Long-wave thresholds of metal tellurides at liquid oxygen temperature are between $1{\cdot}2\ \mu$ for Cu_2Te and $3{\cdot}1\ \mu$ for HgTe. W. SUMMER

537.312.5

5415. Photoconductivity of CdS single crystals at low temperatures. E. A. NIEKISCH. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 291–300 (1951) *In German.*

The monochromatically illuminated area of the synthetic crystal was 0·05 to 0·1 mm wide by a few mm long. The thickness of the crystal was $10\ \mu$. The intensity of the illumination could be altered within the range of $1 : 10^4$. For $\lambda < 5\,000$ Å (ground lattice absorption) there is a distinct max. of conductivity depending on the temperature of each cell. The "selective max." moves, with decreasing temperature, towards the shorter wavelengths. The photocurrent is expressed by $A = c_1'J^r + c_2J^s$, where A = intensity, J = photocurrent, c_1', c_2 = constants, $r > 1$, and $s > 2$. This means that the first increase in intensity is due to a monomolecular (non-radiating), and the second increase to a bimolecular (radiating) recombination. The coefficient of the linear recombination is linearly $\propto$ to the temperature, while the coefficient of the second degree recombination is inversely $\propto$ to the temperature. W. SUMMER

537.312.5

5416. Modification of the current-voltage characteristics of a gaseous photocell with a plane cathode in a magnetic field perpendicular to the cathode. R. BIREBENT. *C.R. Acad. Sci., Paris*, **232**, 1296–8 (*March* 28, 1951) *In French.*

With voltage and illumination constant, the current increases with the intensity of the field and then attains a constant value. At 90 V a max. gain in current of 60% will be attained at a field intensity of 250 Oe. The current-voltage characteristics are logarithmic functions of the voltage up to about 70 V. Above that value the variation of current with voltage increases. The action of the magnetic field is attributed to the suppression of recombination. It is thought that this might lead to a new method for the determination of ionization potentials. W. SUMMER

537.312.5

5417. *p–n* junction rectifier and photo-cell. W. J. PIETENPOL. Letter in *Phys. Rev.*, **82**, 120–1 (*April* 1, 1951).

At 25°C the *p–n* junction Ge rectifier has an impedance of 117 MΩ at 1 000 V reverse, the forward impedance at 1 V being 237 Ω. The saturation current increases by a factor of 10 on heating to 60°C. The rectifier is usable to slightly above the audio range. The *p–n* junction responds to light up to $1{\cdot}9\ \mu$ with a quantum efficiency of unity, and the dark impedance of the cell is of the order of megohms. C. A. HOGARTH

537.312.6

5418. The resistance-minimum in gold. D. K. C. MACDONALD AND I. M. TEMPLETON. Letter in *Phil. Mag.*, **42**, 432–4 (*April*, 1951).

Experiments were made with pure Au and with Au specimens containing various amounts of Cu and Ni impurity. The former results agree with previous work [de Haas and van den Berg, *Physica*, **4**, 683 (1937)]; the latter, however, do not, and indicate that a simple variation with residual resistance cannot be accepted.

537.312.62

5419. Reflection effects in the non-linear theory of superconductivity. W. HEYWANG. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 187–200 (1950) *In German.*

On the Heisenberg–Koppe theory overtones will be produced on reflection of electric waves at a superconductor, owing to the non-linearity of the equations. It is shown that their intensity will be made measurable by superposition of a direct current. R. B. DINGLE

537.312.62

5420. Choice of gauge in London's approach to the theory of superconductivity. J. BARDEEN. Letter in *Phys. Rev.*, **81**, 469–70 (*Feb.* 1, 1951).

London's choice of gauge for the vector potential is derived from the principle that the Schrödinger equation must be invariant with respect to gauge transformations. H. LONDON

537.312.62

5421. Field variation of superconducting penetration depth. J. BARDEEN. *Phys. Rev.*, **81**, 1070–1 (*March* 15, 1951).

Pippard's observation [Abstr. 8754 (1950)] that the penetration depth of a magnetic field into a superconductor depends little on magnetic field is interpreted in terms of the author's theory of superconductivity. In consequence of the assumed low effective masses of the superconducting electrons the wave functions are little affected by a magnetic field and must extend over distances of at least 10^{-4} cm. It is suggested that the transition temperature of superconducting particles will change when the size is reduced below 10^{-6} cm. D. SHOENBERG

537.312.62

5422. Adiabatic magnetization of a superconductor. R. L. DOLECEK. *Phys. Rev.*, **82**, 102 (*April* 1, 1951).

It is shown experimentally that no temperature changes occur for adiabatic application of magnetic fields less than 2/3 H_c to a tin sphere. D. SHOENBERG

537.312.62

5423. Empirical correlation for a thermoelectric property of superconductors. M. C. STEELE AND J. DE LAUNAY. Letter in *Phys. Rev.*, **82**, 276 (*April* 15, 1951).

It is pointed out that $E_0\Theta^2/T_c^2$ has approximately the same value for Pb, In, Sn and Tl. Here Θ is the Debye temperature and E_0 is the e.m.f. in a thermoelectric circuit part of which is superconducting and part made normal by means of suitably applied magnetic fields, the two junctions being at $T = 0$ and $T = T_c$ (the normal transition temperature).

D. SHOENBERG

537.312.62

5424. Electromagnetic relaxation in superconductors. J. EISENSTEIN. *Phys. Rev.*, **82**, 458 (*May* 1, 1951).

The transition from normal to superconductivity of a cylinder cooled in a longitudinal magnetic field or with an axial current flowing in it is discussed on the basis of equations given by Schubert [Abstr. 4995 (1950)]. D. SHOENBERG

537.323

5425. Thermo-electromotive force of BaO and (Ba–Sr)O. K. NOGA. Note in *J. Phys. Soc. Japan*, **6**, 124–5 (*March–April*, 1951).

Generally observed as *n*-type although with poorly activated specimens, *p*-type conduction was found. Thermo-electric power values varied from 1·8 to 2·8 mV/°C in the range from 750 to 1 200°C. Chemical potentials were calculated as from 1·8 to 2·6 eV, activation energies as 0·4 to 0·6 eV, and carrier concentrations as less than 10^{11} cm^{-3}.

C. A. HOGARTH

537.323

5426. Notes on the thermoelectric properties of bismuth. T. SATO. Note in *J. Phys. Soc. Japan*, **6**, 125–7 (*March–April*, 1951).

Experimental results on the thermo-electric power, and its variation with temperature, of pure Bi (Kahlbaum), and of Bi containing 0·2 atomic per cent of Sn, are reported. The value for Bi is about twice that for the alloy over the temperature range 0–200°C, the room temperature values are 0·06 and 0·16 mV/°C, and each material shows a maximum value at about 50°C. C. A. HOGARTH

537.323 : 536.424

5427. Thermoelectric properties of titanium with special reference to the allotropic transformation. H. W. WORNER. *Aust. J. Sci. Res. A*, **4**, 62–83 (*March*, 1951).

A differential method for determining the thermoelectric power of Ti/Pt thermocouples is described. The results are compared with data obtained in direct e.m.f. temp. determinations. The temperature-dependence of the following has been deduced: (*a*) the Peltier coefficient of the Ti/Pt couple; (*b*) the difference between the Thomson coefficients of Ti and Pt; (*c*) the absolute thermoelectric power of Ti. It is shown that abrupt changes in thermoelectric properties accompany the α–β transformation in refined Ti, the transition temperature range being 883 ± 1 to 887 ± 2°C. In a commercial grade the transformation occurs over the range 865 to 970°C. Some effects due to preferred orientation and the elimination thereof are also reported. A.

ELECTRIC DISCHARGES 537.52

537.521

5428. The relationship between the radial concentration variations of excited atoms and electrons in a discharge in thermal equilibrium. H. EDELS. *Proc. Phys. Soc., Lond. B*, **64**, 354–8 (*April*, 1951).

The excitation and Saha equations applicable to gaseous electrical discharges in thermal equilibrium are used to obtain convenient expressions for calculating the radial concentration variations of electrons and excited atoms when the radial intensity variation of one spectral line is known, and when the temperature on the axis of the discharge can be estimated. A.

537.523

5429. The role of the self magnetic field in high current gas discharges. P. C. THONEMANN AND W. T. COWHIG. *Proc. Phys. Soc., Lond. B*, **64**, 345–54 (*April*, 1951).

It is shown that the self magnetic field of a high current discharge plays an important part in determining the radial electron density distribution. The effect of this magnetic field can be treated by adding a "magnetic potential" term to the electrostatic potential in the Boltzmann equation for the radial density. The drift of electrons and ions to the tube walls is equalized at low arc currents by a radial electric field. Since the magnetic field reduces the drift of electrons to the wall whilst having little influence upon the ions, increasing the arc current leads to a progressive reduction of the radial electric field. Probe measurements in an arc at low pressures show that at currents over 50 A, the radial electric field is zero except for a narrow sheath at the wall. The axial density is then mainly determined by the self magnetic field. A theoretical expression is derived for the equilibrium density distribution assuming a balance between the diffusion rates due to the concentration gradient and the magnetic forces. Experiments in a Hg vapour arc at high currents support this theory. A.

537.523 : 538.67

5430. Dynamics of plasmas. II. Plasma with neutral gas. A. SCHLÜTER. *Z. Naturforsch.*, **6a**, 73–8 (*Feb.*, 1951) *In German.*

Abstr., 5072 (1950), previous part. From the impulse balance of ions, electrons and a neutral component, the equation for the ambipolar diffusion and of electric current in a magnetic field is deduced. It is concluded that there is no simple "reduced electric conductivity" transverse to the magnetic field. The influence of its own magnetic field on a glow discharge was examined. F. LLEWELLYN JONES

537.523.2

5431. Electrode reactions in the glow discharge. F. E. HAWORTH. *J. Appl. Phys.*, **22**, 606–9 (*May*, 1951).

The reactions which occur at Ag electrodes in a normal glow discharge in air have been determined. These are: (1) formation of $AgNO_2$ and some Ag_2O at the anode at the rate of 3·4 μg/coulomb; (2) loss of metal from the cathode by chemical action at the rate of 3·5 μg/coulomb (probably the same reaction as (1) with subsequent loss of the reaction products by the greater heating of the cathode, but this hypothesis has not been established); and (3) normal sputtering loss at the cathode at the rate of 0·4 μg/coulomb. These processes result in building a conducting layer on the anode. If the electrode separation is so small that the anode extends into the region of the cathode fall, then the high electric field pulls the newly formed and not very coherent growth upon the anode across into a bridge between the electrodes. A.

537.523.4 : 551.594.221

5432. The electrical processes in the intervals between the strokes of a lightning discharge. D. J. MALAN AND B. F. J. SCHONLAND. *Proc. Roy. Soc. A*, **206**, 145–63 (*April* 10, 1951).

A new electric fluxmeter has been used to record the fields of thunderclouds in the intervals between 388 strokes of 105 flashes to ground at various distances. Most of the inter-stroke interval is found to be occupied by a slow *j* field-change, which is negative when nearer than 5 km and positive when further than 12 km. From this and other information from individual discharges, the *j* process is interpreted as one which links the positively-charged branched top of the lightning-channel successively with fresh regions of negative charge higher and higher within the cloud and so gives rise to separate strokes. Linkage is usually effected by upwardly-directed positive streamers. It is suggested that the charged regions involved in separate strokes form a single continuous column extending nearly vertically and sometimes over 6 km in length. A mechanism is proposed to account for the intermittent discharge of this column and evidence adduced from field-change records in support of it. As some of the negatively-charged regions lie between 3·5 and 9·0 km above ground and the freezing-level in these storms was at a height of 3·7 km, charge-separation must occur in the ice and snow region. Many flashes at a distance show a large, slow, final positive field-change which may be due to a discharge of positive electricity from the top of the cloud to the upper air. A.

537.523.5

5433. Heavy current arcs in a transverse magnetic field. N. L. ALLEN. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 276–7 (*March*, 1951).

Summarizes exptl. data for the effective impedance (arc p.d./current) for pulsed arcs carrying up to 100 A in H (0·4–5 mm Hg pressure) in transverse fields of up to approx. 20 kilogauss. Results are plotted for two types of arc at 5 mm pressure and instantaneous power dissipations of 60 and 25 kW for 65 A arcs at this pressure were obtained.

J. D. CRAGGS

537.525

5434. Gas heating in low pressure gaseous discharges. T. WASSERRAB. *Z. Phys.*, **129** (*No.* 2) 190–201 (1951) *In German.*

After a review of previous published work, a method for calculating the gas temp. in a l.p. discharge is given. The differential equation involved can be solved exactly if radial variations of gas density are ignored. The more practical case, where such radial variations are finite, is treated approximately, and a brief discussion of transient discharge effects is given.

J. D. CRAGGS

537.525

5435. Current fluctuations in the direct-current gas discharge plasma. P. PARZEN AND L. GOLDSTEIN. *Phys. Rev.*, **82**, 724–6 (*June* 1, 1951).

The noise power from a gas discharge plasma may be ascribed to the electron current fluctuations in the plasma due to collisions of electrons with atoms or ions. The noise power, in general, is derived from both the thermal velocities, which are characterized by the electron temperature, and from the d.c. power, which is characterized by the average current. A.

537.525 : 537.525.3

5436. Influence of irradiation on the low frequency electrodeless discharge in chlorine. W. L. HARRIES AND A. VON ENGEL. Letter in *J. Chem. Phys.*, **19**, 514 (*April*, 1951).

Describes expts. with a simplified apparatus on the Joshi effect. The latter is shown to be due to attachment of electrons, on the surfaces of the glass discharge vessel, to Cl atoms formed by photo-dissociation of Cl_2. The mechanism is discussed.

J. D. CRAGGS

537.525.3

5437. A note on Joshi effect. G. V. BAKORE. Letter in *Curr. Sci.*, **19**, 376–7 (*Dec.*, 1950).

A short note criticizing certain explanations of the Joshi effect due to Rais–Ahmed and Gill [Abstr. 341 (1951)]. It is suggested that these explanations should be replaced by Joshi's explanation of the effect. The latter suggests that the discharge current decrease in the Joshi effect is due to negative ions formed from electrons liberated photoelectrically, in turn, from adsorbed layers on the dielectric surfaces in the tube.

J. D. CRAGGS

537.525.3

5438. A note on Joshi effect. H. J. ARNIKAR. Letter in *Curr. Sci.*, **19**, 377 (*Dec.*, 1950).

Criticizes Rais–Ahmed and Gill's recent explanations [Abstr. 341 (1951)] of the Joshi effect on the grounds that these authors used equations (e.g. the Townsend equation $j = j_0 e^{\alpha d}$) not applicable to tubes showing the effect.

J. D. CRAGGS

537.525.3

5439. Comment on notes (on the Joshi effect) by G. V. Bakore and H. J. Arnikar. RAIS-AHMED. *Curr. Sci.*, **19**, 378 (*Dec.*, 1950).

A reply to criticisms of the author's earlier note on some aspects of the Joshi effect. No full explanation of the latter is offered, but various, possibly relevant, properties of discharges are stressed.

J. D. CRAGGS

537.525.3

5440. Negative coaxial cylindrical corona discharges in pure N_2, O_2, and mixtures thereof. C. G. MILLER AND L. B. LOEB. *J. Appl. Phys.*, **22**, 614–21 (*May*, 1951).

Direct-current corona studies were made on coaxial cylinders with inner cylinder at negative potentials in pure N_2, pure O_2 and mixtures of 1% 10% O_2 in N_2, and on clean dry air from 27-mm to 760-mm pressure. Observations of current potential relations from field intensified ionization currents to as near breakdown as possible were made noting thresholds for current transitions, pulsed discharges and other oscillographic as well as visual appearances. Negative wire corona does not exist as such in truly pure N_2. Unless a high series resistance was in the line once the critical region of potential was reached, the gap broke down to an arc. With current-limiting resistor bombardment of the filament with positive ions from the low order pre-discharge released enough gaseous impurity so that after 6 min the resistor could be removed and the internal resistance of the negative ion space charge near the anode held the current at 2 000 μA. The behaviour indicated that breakdown was preceded by a low-current Townsend discharge that cleaned up or conditioned the filament. In all the negative-wire studies the onset thresholds vary with the past history of the wire, and the threshold potential at higher pressures overshoots the minimum operating potential of the discharge once it has set in. Studies with 1% O_2 indicate that the threshold discharge with clean gas is a continuous current with a diffuse glow which in time contracts to a cathode spot with Trichel pulses. Similar behaviour applies to air at lower pressure. There is evidence for a continuous heavy background of Townsend discharge along the whole wire until the visible spot and heavy pulsed discharge appears. Lower pressures in pure O_2 show many current transitions and transitions between discharge forms. A.

537.525.5 : 621.3.015.5 : 621.315.62

5441. Electrical breakdown over insulators in high vacuum. P. H. GLEICHAUF. *J. Appl. Phys.*, **22**, 535–41 (*May*, 1951).

In the investigated range of 5×10^{-3} to 10^{-7} mm Hg, the breakdown voltage over insulators in high vacuum is independent of pressure. Currents of 10^{-11} to 10^{-8} A were observed in the region below breakdown voltage by detecting X-ray quanta with a Geiger–Mueller counter. Pinhole camera X-ray pictures revealed that practically all radiations originate from an area—on the anode a distance from the insulator with a weaker radiation coming from a ring immediately adjacent to the insulator. Current voltage relationships as usually observed in these experiments indicate a roughness factor and an emitting area on the cathode similar to previous findings in vacuum gaps. Current bursts were observed which did not develop into complete breakdown. Oscilloscopic observations revealed that sometimes at breakdown over insulators the voltage on the test sample drops to 2·5 kV; in other cases it falls to less than 100 V. The low-voltage arc-like discharge extinguishes at a current of ~ 1 A for copper electrodes in contact with Pyrex glass. When a resistance in series with the test sample is increased to keep the maximum current < 1 A, no stable discharge is observed. As in a vacuum gap, the breakdown voltage over an insulator is increased by successive breakdowns. Part of this "conditioning" is permanent. The non-permanent part is dependent on the state of the test sample prior to conditioning. The anode does not appear to influence conditioning. When the resistance in series with the test sample allows a discharge current > 1 A to flow, a fast conditioning usually occurs which results in a high permanent breakdown voltage. A.

537.525.8

5442. Probe technique for the measurement of electron temperature. M. A. EASLEY. *J. Appl. Phys.*, **22**, 590–3 (*May*, 1951).

Discontinuities in the slopes of Langmuir probe characteristics for discharges in Hg vapour in the presence of A or Kr gas were eliminated by heating the wire probe by electron bombardment before each reading. The results indicate that in many cases nonlinear probe plots are due to change in the contact potential of the probe and do not mean a non-Maxwellian distribution of electron velocities. Typical probe plots are given for discharges with and without striations, and also for a discharge in gas contaminated by a trace of CO or CO_2. Electron temperature data are listed for representative pressures of gas and Hg vapour and for various discharge currents. A.

537.525.8 : 535.241.42

5443. Electron density and light intensity decay in cesium afterglows. P. DANDURAND AND R. B. HOLT. Letter in *Phys. Rev.*, **82**, 278 (*April* 15, 1951).

Decay of electron density n and light output from an electrodeless discharge, after exciting field removed, is measured. In pressure range 0·02 mm to 0·1 mm, n decays exponentially with a time constant $T_1 \simeq 1$ msec. A minimum of light intensity occurs at 40 μsec with a broad maximum at about 80 μsec. Light intensity decays exponentially after this maximum with a time constant $T_2 = T_{1/2}$, which shows light intensity $\propto n^2$. At low pressures n is determined by diffusion; below 0·3 mm n follows recombination law $\partial n/\partial t = -\alpha n^2$: α varies with p at constant temp. Light intensity $\propto n^2$ after 400 μsec, but not at shorter times. Results are discussed.

F. LLEWELLYN JONES

537.525.9

5444. Distribution of the electric field in a three-electrode gas discharge tube with a high back-voltage. V. D. ANDREEV, L. E. LEVINA AND B. G. MENDELEV. *J. Tech. Phys., USSR*, **21**, 149–54 (*Feb.*, 1951) *In Russian.*

The potential of the plasma between anode and grid of a 3-electrode gas-discharge tube during the inverse half-period was investigated by taking oscillograms of probe currents. The tube was filled with Hg vapour, at a pressure of only a few μ. The grid was a Ni disk with 5 openings of 20 mm dia.; anode–cathode distance 60 mm 3 probes of 0·7 mm dia were inserted at 10, 30 and 50 mm from the anode. The discharge tube was excited with short current pulses and then a back-voltage applied to the anode and kept constant during the whole deionization period. Simultaneously with the back-voltage a

negative voltage was applied to the grid. The back-voltage was — 4 000 V, grid voltage — 750 or 500 V. It was found that the potential of the plasma between grid and anode at the beginning of the deionization is near the cathode potential and becomes negative only after the grid openings have been filled up with layers of the space charge. This instant determines the inception of the actual potential division in the tube and this occurs the later, the higher the intensity of the preceding discharge current, and the lower the p.d. between grid and cathode. In the main experiment the discharge current was 3 A. At the critical moment the ionic current on the probe changes its sign and becomes electronic, of such an intensity that the amplifier in the probe circuit is overloaded. This proves that the probe suddenly becomes more positive than the surrounding plasma, which can only be explained by a discontinuous lowering of the plasma potential. B. F. KRAUS

537.527.4

5445. On breakdown lags in compressed nitrogen and compressed hydrogen. A. BOULLOUD. *C.R. Acad. Sci., Paris*, **232**, 958–9 (*March* 5, 1951) *In French.*

A short note describing expts. on spark lags in N and H (approx. 70 to 300 lb/in^2 pressure), between parallel plate electrodes of various metals. No data on statistical lags are given, but the mechanism of cold emission of electrons from cathodes is briefly discussed. J. D. CRAGGS

537.529

5446. On the breakdown of alumina at higher temperature. H. MIYAZAWA AND J. OKADA. *J. Phys. Soc. Japan*, **6**, 55–9 (*Jan.–Feb.*, 1951).

The breakdown voltage, V_m, decreases exponentially with increasing temperature at high temperatures. It is shown that $V_m \propto \sqrt{(R)}$ where R is the resistivity, and this relation can be derived from the theory of dielectric breakdown. E. RUSHTON

537.529 : 621.315.5.066.6

5447. The electric tunnel effect across thin insulator films in contacts. R. HOLM. *J. Appl. Phys.*, **22**, 569–74 (*May*, 1951).

Existing calculations on the tunnel effect through thin films in contacts apply to very weak and very strong electric fields. The present paper completes the picture by the treatment of intermediate cases, which are important for many contact applications. A.

X-RAYS 537.531

537.531

5448. The X-rays emitted by arsenic vapour excited in an electromagnetic field of very high frequency. J. GOENS. *Bull. Acad. Roy. Belg. Cl. Sci.*, **36** (*No.* 12) 937–40 (1950). *In French.*

Arsenic vapour at low press. was excited at 200 Mc/s and the resulting X-rays studied, for example, by their absorption in aluminium. X-rays with wavelengths ~ 1 Å were detected. J. D. CRAGGS

537.531

5449. Penetration and diffusion of X-rays. Calculation of spatial distributions by polynomial expansion. L. V. SPENCER AND U. FANO. Letter in *Phys. Rev.*, **81**, 464–6 (*Feb.* 1, 1951).

Presents a method of calculating the distribution of X-rays in uniform media. The method is applied to a plane monodirectional source of 10·2-MeV X-rays in Pb and to a Co^{60} isotropic point source in water. J. THEWLIS

537.531 : 535.33.072

5450. A curved-crystal [X-ray] spectrograph of high resolving power. B. G. GOKHALE. *C.R. Acad. Sci., Paris*, **232**, 1086–8 (*March* 12, 1951) *In French.*

Conditions for high resolving power are discussed. A. R. STOKES

537.531 : 535.34

5451. The absolute absorption coefficient of germanium and the fine structure in the *K* edge of some of its components. H. GLASER. *Phys. Rev.*, **82**, 616–21 (*June* 1, 1951).

The fine structure of the K absorption limit of Ge in GeH_4, Ge_2H_6, $GeCl_4$ and $GeBr_4$ has been obtained with absolute values under conditions of high resolution with a double crystal X-ray spectrometer. Results are compared with existent theory and previous measurements and discrepancies are pointed out. The question of the location of an absorption edge is considered along with the Kossel structure appearing in the Ge hydrides. A.

537.531 : 535.343

5452. On the width of $K_{\alpha 1}$ lines. S. KICHENASSAMY. *C.R. Acad. Sci., Paris*, **232**, 1074–6 (*March* 12, 1951) *In French.*

Shows that the width of the $K_{\alpha 1}$ line for elements Rb to Sn follows a Z^4 law and not a Z^3 law. This is attributed to the effect of Auger transitions. J. THEWLIS

537.531.08 : 615.849 : 621.386.8

5453. An integrating X-ray dosemeter, reading directly in skin dose. R. OLIVER. *J. Sci. Instrum.*, **28**, 97–9 (*April*, 1951).

Includes an ionization chamber covering the whole X-ray beam in the master cone of the set, a cathode follower circuit mounted on the cone, and a trigger unit (near the control panel) based on a cold cathode relay valve. The use of special high insulation relays and electrometer valves is avoided. The indicator steps are made to represent 5 r skin dose for any treatment condition by the use of variable bias (calibrated directly in terms of, for example, applicator field size) on the trigger circuit. The calibration remains constant within $\pm 2\%$ over a period of months and is sensibly independent of mains voltage variations. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

5454. On Newton's image relationship in electron optics. P. FUNK. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 304–5 (1950) *In German.*

Gives a simple mathematical solution to the problem of determining the conditions under which Newton's image relation is satisfied. J. THEWLIS

537.533.72

5455. Calculation of the field-distribution along the axis of a magnetic electron lens from pole-piece measurements and total flux. F. LENZ. *Optik*, **7** (*No.* 4–6) 243–53 (1950) *In German.*

In order to calculate the optical properties of electron lenses it is necessary to know the field distribution. This can be obtained approximately from a knowledge of the pole-piece dimensions and the magnetic properties of the pole-piece material when saturated. J. THEWLIS

537.533.72 : 621.385.833

5456. Optical power of short electron lenses. O. I. SEMAN. *J. Tech. Phys., USSR*, **20**, 1180–93 (*Oct.*, 1950) *In Russian.*

It is shown that Brüche and Scherzer's well-known approximation formula for focal length $f^{-1} = 0{\cdot}125\,\phi_1^{-1}\int_{z_0}^{z_1}\phi^{12}\phi^{-\frac{3}{2}}dz$, where $\phi(z)$ is the electric field potential along axis z and $\phi^1 = d\phi/dz$, can lead to a 100% error in the case of short lenses. Corrected formulae are derived which are accurate within 5–13% in all cases for electrostatic and magnetic lenses, and contain a new constant $R = r\,\phi^{\frac{1}{2}}$. It is shown that the assumption $R =$ const. instead of the usual $r =$ const. is particularly useful for short, single symmetrical electron lenses, and that $\Delta f/f$ and relative radial displacement $\Delta r/r$ of the electron beam in a short magnetic lens are always below lens thickness l/f. A. LANDMAN (R)

537.533.72

5457. Correction to Walter Glaser's paper, "Calculation of the optical constants of strong magnetic lenses." W. GLASER. *Ann. Phys. Lpz.*, **8** (*No.* 5–8) 423 (1951). See Abstr. 8776 (1950).

537.533.72

5458. Scattering phenomena in electron microscope image formation. C. E. HALL. *J. Appl. Phys.*, **22**, 655–62 (*May*, 1951).

Equations are derived for the relative intensities in electron microscope images formed without a limiting aperture in the objective lens. Three components of intensity at the image plane can be distinguished: I_T, a transmitted intensity of very small relative aperture; I_K, an intensity scattered within the effective aperture of the objective lens; and I_B, a background intensity which does not contribute to the recognizable image. The equations derived involve two scattering cross-sections, both of which are readily measurable under normal operating conditions. The form of the equations is verified experimentally; and cross-sections are measured for Be, SiO, Cr, Ge, Pd, Pt and U. The effect of altering the beam potential is discussed in the light of the results and the minimum detectable increment in specimen thickness due to scattering is estimated. A.

537.533.72 : 621.318.2 : 621.385.833

5459. Permanent magnet lenses. J. H. REISNER. *J. Appl. Phys.*, **22**, 561–5 (*May*, 1951).

Permanent magnets have been successfully used to energize magnetic lens pole-pieces for high resolution electron microscopy at direct magnifications of 7 000× with 30 kV electrons, and 6 000× at 50 kV. Stray magnetic fields, which have previously limited high magnification and high resolution, have been minimized by using two circuit gaps in parallel and by surrounding the assembly with a magnetic shield connected to the external pole pieces of the two gaps. Magnetomotive forces of 1 400 gilberts have been obtained. A single magnet, magnets in bucking arrangement, and configurations involving magnets disposed either radially or parallel to the optical axis of the lens, have been successfully utilized. The effects of various magnetic circuit parameters on the design and operation of the lens system have been studied. A.

537.533.72 : 771.534

5460. The gradation of the ultramicroscopic picture. B. V. BORRIES. *Z. wiss. Mikr.*, **60**, 69–82 (*Feb.*, 1951) *In German.*

An examination of gradation, or the relationship between the brightness of a point on an electron microscope (positive) picture and the mass per unit area at the corresponding point of the object. Electron scattering in the object, the characteristic curves for negative and positive materials, and the exposures in the negative and positive processes are considered. Curves show the gradation for a variety of commercial printing papers and its dependence on the other parameters. S. T. HENDERSON

537.533.72

5461. On the spiral orbit spectrometer with two converging circles. G. MIYAMATO. *J. Phys. Soc. Japan*, **6**, 68–9 (*Jan.–Feb.*, 1951).

Describes briefly a modification whereby 2 pairs of magnet pole pieces allow 2 orbit radii to be used, and particles of 2 momentum groups to be measured simultaneously. See also *Proc. Phys. Math. Soc. Japan*, **24**, 676 (1942). T. G. PICKAVANCE

537.533.72

5462. Source discharger for magnetic lens beta-ray spectrometers. J. L. WOLFSON. Letter in *Rev. Sci. Instrum.*, **22**, 280–2 (*April*, 1951).

The positive charge developed on a negatron source, mounted on a plastic foil, is neutralized by a low-velocity electron beam. If the pressure in the spectrometer is not too low, the possibility exists of discharging a positron source with the positive ions produced by the electron beam in the residual gas. Curves of the measured electron momentum of the 22·5 keV, *K*-internal conversion line from Tm^{170}, with various source backings, showing the effect of the discharger are given. J. HUGHES

537.533.73

5463. An improved electron diffraction camera. P. W. ALLEN, H. MACKLE AND L. E. SUTTON. *J. Sci. Instrum.*, **28**, 144–51 (*May*, 1951).

An apparatus for studying the diffraction of fast electrons by gaseous molecules is described. It is essentially conventional, but there are incorporated, both in the camera itself and its ancillary instruments, a variety of features which increase considerably the ease of manipulation, the quality of the diffraction patterns recorded, and the overall accuracy of the final results. Among the more important of these are: (i) a two-lens electron optical system, (ii) a device

enabling direct measurement of the accelerating voltage to an absolute accuracy of 0·1%, (iii) a method of measuring to the nearest tenth of a millimetre the distance between the scattering material and the centre of the recording plate, and finally, (iv) a "quasi-hydrodynamic" jet of simple design and considerable temperature range mounted to achieve stability of position yet flexibility of adjustment. A.

537.533.74

5464. Relative back-scattering of electrons and positrons. W. MILLER. Letter in *Phys. Rev.*, **82,** 452 (*May* 1, 1951).

An evaluation of the back-scattering coefficient for electrons and positrons, based on relativistic cross-sections, was made using the Bothe formulae [Abstr. 5877 (1950)]. The results agree well with the observed values. J. A. FRANKS

537.533.75

5465. Interaction of slow electrons and surface films of ionic crystals. H. JACOBS AND D. DOBISCHEK. *Phys. Rev.*, **81,** 1019–22 (*March* 15, 1951).

A study has been made of the interactions of slow electrons and thin films of KCl evaporated on a Ni target. Experimental diodes were made up which contained a rotating anode, an oxide coated cathode, and a KCl source. The crystal was evaporated to the anode and the anode rotated to the place where the oxide coated cathode faced the deposit. Since electrical charges on the KCl could enhance or lower the current from the cathode, a method was set up whereby the accumulation and release of charging could be studied. It was found that electrons could be trapped in the film and released by bombarding electrons at a critical kinetic energy. The energy of the electrons needed to release the trapped electrons was found to be very near the same energy required by photons, as described in work on F' centres in KCl. It was concluded that the electron affinity of evaporated films of KCl must be $<0{\cdot}5$ eV. At critical kinetic energies, the bombarding electrons caused dissociation of the film of compound coating the anode. When the electrons attained an energy equivalent to the heat of formation of the KCl, decomposition occurred. This agrees with previous studies on oxides and points out that the same equivalence of electron energy and heat of formation holds for ionic crystals, such as KCl, as for thin films of oxides. A.

537.533.75

5466. Distribution of energy loss of electrons in aluminum. R. D. BIRKHOFF. Letter in *Phys. Rev.*, **82,** 448 (*May* 1, 1951).

The conversion electrons of Ba^{137} were examined before and after passing through a thin Al foil with a DuMond β-spectrograph [Abstr. 3255 (1949)], having a high resolution. The width of the energy-loss distribution is considerably greater than predicted by theory. J. A. FRANKS

537.533.8 : 537.531

5467. Investigations of the spatial distribution of X-ray bremsstrahlung from a 5-MeV betatron. H. KULENKAMPFF, M. SCHEER AND R. SCHITTENHELM. *Z. Phys.*, **129** (*No.* 2) 202–18 (1951) *In German.*

A betatron in which special precautions had been taken to get a well-defined electron beam, was used for the experiments. The spatial distributions of the bremsstrahlung for various target materials (Al, Cu, W) and for various target thicknesses were determined by measuring the intensity of the neutrons ejected from a small Be body in the X-ray field. As expected, the high electron energies give a sharp concentration of the X-rays in the direction of the beam. The form of the distribution curves and the relative intensities are shown to be in good agreement with theory. K. JOHNSEN

537.533.

5468. Natural spread of the conic distribution of the Čerenkov radiation. Y.-Y. LI. Letter in *Phys. Rev.*, **80,** 104 (*Oct.* 1, 1950).

A lower limit for the half-breadth of the natural spread is estimated from equations due to Frank and Tamm [*Comptes Rendus USSR*, **14,** 109 (1937)] by taking into account that the mean free path of the electrons is finite. [See Abstr. following]. P. T. LANDSBERG

537.533.9

5469. Natural spread of the conic distribution of the Čerenkov radiation. Y.-Y. LI. Letter in *Phys. Rev.*, **82,** 281 (*April* 15, 1951).

A previous estimate of the lower limit for the half-breadth (preceding Abstr.) is in disagreement with experiment. Coherence of wavelets from succeeding free paths must also be considered. P. T. LANDSBERG

537.533.9 : 538.3

5470. Applications of the radiation from fast electron beams. H. MOTZ. *J. Appl. Phys.*, **22,** 527–35 (*May* 1951).

The radiation from fast electron beams passing through a succession of electric or magnetic fields of alternating polarity is examined. The radiation of maximum frequency is emitted in the forward direction. If the deflecting fields are not too large, a semi-qualitative argument shows that the maximum frequency is the lowest possible harmonic. The frequencies emitted are determined by studying the Doppler effect, and the angular distribution of radiated energy as well as the total radiation are calculated in a simple straight-forward manner with reference to well-known formulae of special relativity. The question of the coherence of the radiation is discussed. The spectral distribution of radiated energy is then calculated more exactly. It is concluded that several applications of the radiation appear possible. A scheme for obtaining millimetre-waves of considerable power is outlined. The upper limit of the power in a band extending down to a wavelength of 1 mm is calculated to be of the order of several kW for a beam of 1 A and an energy of 1·5 MV. The use of the radiation for speed monitoring of beams with energies up to 1 000 MV is discussed. A.

537.533.9 : 539.185

5471. Determination of the non-electromagnetic interaction between electrons and neutrons. A. AKHIEZER AND I. POMERANCHUK. *J. Exp. Theor. Phys.*, **19,** 558 (*June*, 1949) *In Russian.*

537.534

5472. The focusing principles of high energy particle accelerators. I. M. HOYAUX. *Atomics, Lond.*, **2,** 105–11 (*April*, 1951).

This, the first of three papers on focusing forces in particle accelerators, gives the elementary theory of focusing by electric and magnetic fields, particularly those with axial symmetry. J. H. FREMLIN

537.534

5473. Scattering losses in the synchrotron. J. M. GREENBERG AND T. H. BERLIN. *Rev. Sci. Instrum.*, **22,** 293–301 (*May*, 1951).

Scattering losses in various electron and proton synchrotrons by residual gas molecules are obtained for a variety of conditions. Evaluation is made of the effects of (1) injection energy of the particles, (2) the spread of the injected beam, (3) the pressure of the residual gas, (4) the rate at which energy is supplied to the beam particles, and (5) the aperture of the accelerator. It is shown that multiple scattering is the really important factor and that losses due to single scattering are of relative importance only when the total effect of single and multiple scattering is rather small. Scattering losses are tabulated and estimates made of the residual gas pressures in synchrotrons which will not produce prohibitively large losses. A.

537.534

5474. Instrumentation of the M.I.T. cyclotron for the study of nuclear reactions. K. BOYER, H. E. GOVE, J. A. HARVEY, M. DEUTSCH AND M. S. LIVINGSTON. *Rev. Sci. Instrum.*, **22,** 310–20 (*May*, 1951).

The emergent beam from the cyclotron has been focused to bombard targets placed in an evacuated chamber behind shielding walls. Heavy charged particle products from the targets can be counted and identified as to charge and mass by three proportional ionization chambers in time coincidence, utilizing the difference in specific ionization near the end of the particle range. Energy spectra at fixed angles are observed with an automatic foil changer which interposes Al absorbers between target and detector. Angular distributions can be studied by rotating the detector about the target with a remote-controlled selsyn drive. Rapid automatic recording of data is accomplished with count storage circuits, a beam current integrator, mechanisms for scanning through a preselected set of absorber foils, and a pen-recorder. Reactions studied to date include (d, p), (d, t), (d, α), (p, d), and elastic and inelastic scattering of protons, deuterons and α-particles. A.

537.534

5475. Negative ions and charge neutralization in the cyclotron. E. J. LOFGREN. *Rev. Sci. Instrum.*, **22,** 321–3 (*May*, 1951).

Evidence is given for the presence of negative H ions in the synchrocyclotron. They are lost by charge neutralization before they reach an energy of about 3 MeV. Protons have been made to circulate in the cyclotron without acceleration after they have reached an energy of 5 to 22 MeV and are found to be lost with a half-life of $\frac{1}{3}$ to 2 sec. A.

537.534 : 621.384.61

5476. The proton deuteron rf system for the Berkeley synchrocyclotron. K. R. MACKENZIE. *Rev. Sci. Instrum.*, **22,** 302–9 (*May*, 1951).

An r.f. system is described which allows the acceleration of either 190 MeV deuterons or 350 MeV protons in the Berkeley 184-in cyclotron. The dee is connected to a large cross-section line, which is in turn connected, through a rotating condenser, to a short section of grounded line of approximately the same cross-section. At the upper frequency limit of 23·2 Mc/s the dee and dee stem oscillate as a half-wave line, while the grounded line, which is about $\lambda/4$ long, oscillates in the opposite phase. At the l.f. limit of 9·5 Mc/s, the whole system looks like a $\lambda/4$ line. The oscillator which feeds the system is described. A.

537.534.72

5477. Mass spectrometer as an instrument for the analysis of matter. J. GEERK. *Arch. tech. Messen, Issue No.* 179 (*Ref. J*386–1) *T*139–*T*140 (*Dec.*, 1950) *In German.*

Describes the principles underlying the mass spectrometer, its physical and technical details in general, and 3 types of mass spectrometers (Nier, and Siri models) in more detail. F. LACHMAN

537.534.72

5478. A new magnetic period mass spectrometer. L. G. SMITH. Note in *Rev. Sci. Instrum.*, **22,** 115–16 (*Feb.*, 1951).

Ions of limited mass range are decelerated after flight through 180° in a uniform magnetic field, by a pulse applied to a slit system. They miss the ion source on subsequent revolutions and, after a predetermined time, the remaining ions are deflected into a detector by a second decelerating pulse applied to the same slit system. Resolution may be better than with other magnetic period instruments.

T. G. PICKAVANCE

537.534.72

5479. Fringing field effects on first-order focusing in magnetic spectrographs. C. REUTERSWÄRD. *Ark. Fys.*, **3,** *Paper* 5, 53–62 (1951).

The fringing flux influence on ion paths in the median plane of magnetic spectrographs of the short uniform-field type is investigated, and the corrections to be applied to the ideal-field theory are given to the first order of approximation. This influence consists in displacing the posterior principal point of the ion lens connected with the deflecting field without altering the focal distance. In double-focusing spectrographs the conditions of simultaneous velocity and directional focusing will be modified. A.

537.534.74

5480. Erratum: Energy dependence of proton-proton scattering, 18·8 to 31·8 MeV. B. CORK. Letter in *Phys. Rev.*, **82,** 103 (*April* 1, 1951).

See Abstr. 1875 (1951).

537.534.74 : 539.172.13

5481. The scattering of protons by tritons. R. S. CLAASSEN, R. J. S. BROWN, G. D. FREIER AND W. R. STRATTON. *Phys. Rev.*, **82,** 589–96 (*June* 1, 1951).

The differential cross-section for the scattering of

protons by tritons has been measured in the angular range of 41·85° to 163° in the laboratory (54·7° to 168·7° in the centre-of-mass system) at five energies between 2·54 and 3·50 MeV. A small volume (42 cm^3) scattering chamber with an angular range of 17° to 163° was used for these measurements. Measurements of proton-proton and proton-He cross-sections and a comparison of the results with those obtained previously with a large scattering chamber showed that this small chamber gave results too high (about 3%) at the low scattering angles. These measurements determined a correction which was applied in the calculation of the p–T cross-sections from the experimental data. The centre-of-mass differential cross-section varies between a maximum of $0{\cdot}243\times10^{-24}$ cm^2 per unit solid angle at 54·7° and 3·5 MeV and a minimum of $0{\cdot}065\times10^{-24}$ cm^2 per unit solid angle at 109·5° and 3·5 MeV in the angle and energy range studied. The cross-sections considered as a function of angle display a strong minimum, near 100°, in the centre-of-mass co-ordinate system. The cross-section for a given angle is a slowly varying function of energy. A.

537.534.75

5482. Calculation of the range-energy relation for protons up to high energies in Ilford C2 emulsion. L. Vigneron. *C.R. Acad. Sci., Paris*, **232**, 1199–201 (*March* 19, 1951) *In French.*

A calculation, based on the energy-loss formula due to Livingstone and Bethe [*Rev. Mod. Phys.*, **9**, 245 (1937)] is given for the range-energy relationship for protons. By suitably fixing the value of one of the constants in the equation, the calculation yields results which are in agreement with most published experimental relationships. The calculated relationship is given for protons up to 230 MeV. A. C. COATES

537.534.75

5483. The energy loss of slow deuterons in heavy ice. A. P. French and F. G. P. Seidl. *Phil. Mag.*, **42**, 537–54 (*May*, 1951).

A review is made of experimental evidence on the energy losses of protons and deuterons in materials of low atomic number, at energies below about 350 keV. The discrepancies between results of different experiments are discussed, and an attempt is made to arrive at a plausible curve of energy loss as a function of energy for deuterons in heavy ice at energies below 700 keV. The region 0–100 keV. which is of considerable interest in the study of the D–D reaction, is given special attention. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

5484. A mass spectrometer source allowing the use of high gas pressures in the ionization chamber. G. Philbert. Letter in *J. Phys. Radium*, **12**, 143–4 (*Feb.*, 1951) *In French.*

Briefly describes the source arrangement, for high ($\sim 10^{-2}$ mm Hg) gas pressures, which enables a mass spectrometer to be better used in certain expts., e.g. in kinetics of chemical reactions, etc. J. D. CRAGGS

537.542

5485. On the behaviour of NH_3-filled counter tubes. H. Neuert and J. Geerk. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 93–8 (1950) *In German.*

Describes the improved life of self-quenched Geiger counters when filled with NH_3 in place of the more usual fillings. Pulse size/voltage curves are given for alcohol/argon and NH_3 counters using α-, β- and γ-rays in both cases. The latter filling gives better counting in the proportional region of the characteristics. The discharge mechanisms in the NH_3 counters are then discussed with reference to the results of a special mass spectrometer study of the products of dissociation in a counter. Ionization functions for 5 positive ions, thus formed, are given. J. D. CRAGGS

537.542

5486. The theoretical efficiency of X-ray counters. G. Barrère. *J. Phys. Radium*, **12**, 107–11 (*Feb.*, 1951) *In French.*

The efficiencies of tube counters are studied theoretically for arbitrary window and electrode arrangements, and exptl. results for counters studied by Maze are then quoted, and discussed in the light of the theoretical work. Data for Cu $K\alpha_1$ radiation and two counter gas fillings are given. J. D. CRAGGS

537.542

5487. Improvement of Geiger-Müller counters containing CO_2. J. Labeyrie. Letter in *J. Phys. Radium*, **12**, 146–8 (*Feb.*, 1951) *In French.*

The addition of a small amount of alcohol (1 cm Hg) to a counter containing CO_2, gives a plateau > 200 V long, at a counting rate of 15 000/min, if the potential on the anode is restored in 2×10^{-4} sec. J. HUGHES

537.542

5488. Quantum efficiency of bismuth counters for electromagnetic radiation of 0·07 MeV to 2·8 MeV energy. R. J. Hart, K. Russel and R. M. Steffen. Letter in *Phys. Rev.*, **81**, 460–1 (*Feb.* 1, 1951).

A redetermination of the efficiency of G.M. counters of the Bi type is made, using modern data on decay schemes and angular correlation. The average efficiency increases from a minimum of 0·7% at 0·7 MeV γ-energy to $\sim 2\%$ at 3 MeV γ-energy. G. F. J. GARLICK

537.542

5489. On the discharge mechanism of [the] slow counter. I. Kita. *J. Phys. Soc. Japan*, **6**, 99–103 (*March–April*, 1951).

537.542

5490. On the temperature effect of Geiger-Müller counters. G. Fujioka, I. Kita and O. Minakawa. *J. Phys. Soc. Japan*, **6**, 103–7 (*March–April*, 1951).

537.542

5491. Automatic sample changer for windowless gas flow counters. W. N. Nye and J. D. Teresi. *Analyt. Chem.*, **23**, 643–6 (*April*, 1951).

The instrument records the time in seconds and automatically changes each sample after a predetermined number of counts have been made. A feature is included which preflushes two samples in

10 seconds while a previous sample is in the counting position. The geometry of each sample well was perfectly reproducible and the measurements of the same samples at various intervals of time were also reproducible. A.

537.542

5492. The construction and use of small boron trifluoride chambers. R. CAILLAT, C. LALLEMENT AND G. VALLADAS. *J. Phys. Radium*, **12**, 74–80 (*Feb.*, 1951) *In French.*

This is discussed with particular reference to the design of the electronic equipment for optimum resolving time and signal to noise ratio. J. HUGHES

537.542

5493. Calculation of the error in ionization measurements made with a chamber having no guard-rings. H. TELLEZ-PLASENCIA. *J. Phys. Radium*, **12**, 89–92 (*Feb.*, 1951) *In French.*

In previous work [Abstr. 4013 (1949), 4152 (1950)] general equations are derived for the relationship between incident X-ray energy and the ionization (including that from fluorescence radiation) produced in a chamber with guard-rings. The present paper extends this work by deriving the correction to be made when there are no guard-rings present. L. E. MUSSELL

537.542 : 519.271

5494. The statistical theory of errors in measurements with the ionization chamber. I. YA. BARIT AND M. I. PODGORETSKIĬ. *J. Tech. Phys., USSR*, **19**, 730 (*June*, 1949) *In Russian.*

537.542

5495. Silver bromide crystal counters. K. A. YAMAKAWA. *Phys. Rev.*, **82**, 522–6 (*May* 15, 1951).

Single crystals of AgBr and mixed crystals of NaCl and AgCl have been used to count ionizing radiation. The energy per ion pair in AgBr for electrons was found to be approximately 5·8 eV. The mobility and the mean free path for the trapping of electrons in the conduction band of AgBr crystals at 77°K were found to be 210 cm^2/volt-sec and 5×10^{-4} cm^2/volt, respectively. A study of the polarization of the counters for beta- and gamma-radiation was also made. A.

537.542

5496. A scintillation counter for detecting fast neutrons. G. N. HARDING. Letter in *Nature, Lond.*, **167**, 437 (*March* 17, 1951).

537.542

5497. The problem of using scintillation crystals as proportional counters for high energy particles. F. X. ROSER AND T. BOWEN. Letter in *Phys. Rev.*, **82**, 284 (*April* 15, 1951).

Proportionality of response is found for anthracene to μ-mesons of up to 170 MeV energy. Results indicate a similar behaviour for other particles up to their minimum ionization energy. G. F. J. GARLICK

537.542

5498. Response of an anthracene scintillation counter to protons. H. B. FREY, W. M. GRIM, W. M. PRESTON AND T. S. GRAY. *Phys. Rev.*, **82**, 372–3 (*May* 1, 1951).

The proton response of an anthracene scintillation counter below 3·7 MeV has been measured. When combined with previously published data up to 17 MeV, a smooth curve results. An attempt was made to correlate the efficiency of the light output with the ion density by plotting the differential light output as a function of the differential energy absorption for both electrons and protons. The available information is not sufficiently extensive or accurate to determine whether or not the proton and electron data coincide. A.

537.542

5499. On the analysis of [Johnson's] quenching circuit for slow counters. G. FUJIOKA, I. KITA AND O. MINAKAWA. *J. Phys. Soc. Japan*, **6**, 95–8 (*March–April*, 1951).

See Johnson, *Rev. Sci. Instrum.*, **9**, 218 (1938).

537.542

5500. Delayed coincidence circuit for scintillation counters. A. LUNDBY. *Rev. Sci. Instrum.*, **22**, 324–7 (*May*, 1951).

Using organic crystals or liquids as scintillators and 1P21 photomultipliers as detectors, a delayed coincidence circuit has been designed for measuring nuclear lifetimes in the region 10^{-10}–10^{-7} sec. The pulses from the photomultipliers were amplified in distributed amplifiers and applied to a Ge diode bridge coincidence circuit. The apparatus has been used for measuring scintillation decay times, the lifetimes of nuclear transitions, and the time of flight of light over distances of the order of one metre. A.

537.542 : 621.318.572

5501. A binary counter with impulse-controlled addition and subtraction. A. PEUTEMAN. *C.R. Acad. Sci., Paris*, **232**, 1082–4 (*March* 12, 1951) *In French.*

Normal binary counting may be transformed to a subtraction process by changing the transition that operates the succeeding stage (i.e. changing $A \rightarrow B$ for $B \rightarrow A$). It is briefly shown that this may be achieved electronically by using negative pulses for addition and positive for subtraction, the sign-sensitivity of the flip-flop circuit being switched by simply changing the bias. A. J. KENNEDY

537.542 : 771.4

5502. A triggering device for arc discharge lamps used in cloud chamber photography. R. K. DAS. *Indian J. Phys.*, **24**, 497–500 (*Nov.*, 1950).

In addition to its normal function as a trigger, the circuit effectively controls the requisite time delay between the passage of a cosmic-ray particle and its subsequent illumination for photography. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

5503. Electron loss cross sections for hydrogen atoms passing through hydrogen gas. J. H. MONTAGUE. *Phys. Rev.*, **81**, 1026–34 (*March* 15, 1951).

Measurements have been made for H atoms moving with kinetic energies between 45 and 329 keV. At these energies the cross-sections were $6\cdot6_6$ and $2\cdot2_1\times10^{-17}$ cm^2, respectively (error $\pm10\%$). Between

120 and 329 keV the cross-section was found to vary approximately as E^n (E = kinetic energy of the atom, $n = -0{\cdot}70 \pm 0{\cdot}05$). A.

537.561

5504. Ionization by the collision of pairs of metastable atoms. M. A. Biondi. Letter in *Phys. Rev.*, **82,** 453 (*May* 1, 1951).

Experiments show that electrons are produced in this way after the interruption of a discharge. From data the metastable ion diffusion coefficient D_m and the frequency Cp of de-exciting collisions with gas atoms are determined, p being the gas pressure. For He, $D_m p = 520 \pm 20$ and $c = 55 \pm 6$ (mm Hg sec)$^{-1}$ and for neon $D_m p = 200 \pm 20$ and $c = 230 \pm 20$. G. J. KYNCH

537.563

5505. Mass spectra of the deuteromethanes. V. H. Dibeler and F. L. Mohler. *J. Res. Nat. Bur. Stand., Wash.*, **45,** 441–4 (*Dec.*, 1950).

The four deuteromethanes have been synthesized and their mass spectra obtained with a mass spectrometer. The sensitivities of the molecule ions of CH_4 and of CD_4 are equal within the estimated uncertainty. The total ionization is the same for CH_4, CH_3D and CH_2D_2 but is significantly low for CD_4. The mass spectra of the deuteromethanes are not predictable from CH_4 by statistical considerations alone. In agreement with previously published data on CH_3D, probability factors of 1·18 and 0·45 were observed for the dissociation of an H atom or a D atom compared with the dissociation of an H atom from CH_4. Whereas these factors remain approximately constant for subsequent dissociations in the same molecule, they differ markedly for the three protiodeuteromethanes. Wide divergence is observed for some probability factors obtained in dissociations of two or more atoms. A.

537.563

5506. Temperature variation of mass spectra of hydrocarbons. R. M. Reese, V. H. Dibeler and F. L. Mohler. *J. Res. Nat. Bur. Stand., Wash.*, **46,** 79–84 (*Feb.*, 1951).

Measurements have been made in the temperature range of 100° to 300°C on a number of selected mass peaks in the spectra of 21 compounds. The sensitivity (current per unit pressure) of the maximum peak and the ratio of other peaks to the maximum peak have been measured as a function of temperature of the ion source. The percentage change of sensitivity or of pattern per deg C at 250°C has been defined as the temperature coefficient. This changes very little with temperature. The temperature coefficients of sensitivity for A and N_2 are $-0{\cdot}23$ and $-0{\cdot}18$. Sensitivity coefficients of the maximum peaks of the hydrocarbons range from $-0{\cdot}2$ to 0; and pattern coefficients of most of the peaks have small negative or positive values, but the molecule ions have larger negative coefficients up to $-1{\cdot}5\%$ per degree. There is an inverse correlation between the size of the molecule ion peak relative to the sum of all the peaks and the temperature coefficients. Spontaneous dissociation of molecule ions because of thermal energy can account for this correlation between peak height and temperature coefficient. Published appearance potential data for a few of these molecules give a basis for computing the stability of the ions and show that thermal dissociation is to be expected at 200° to 300°C. A.

537.56

5507. Cross sections for ion/atom collisions in He, Ne and A. J. A. Hornbeck and G. H. Wannier. Letter in *Phys. Rev.*, **82,** 458 (*May* 1, 1951).

Quotes results for the mobility of Ne^+ in neon and deduces therefrom that the hard sphere model for the collisions explains the results in high electric fields. J. D. CRAGGS

537.58

5508. Thermionic emission of platinum coated tungsten. M. D. Kruglova and I. L. Sokolskaya. *J. Tech. Phys., USSR*, **19,** 1292 (*Nov.*, 1949) *In Russian.*

537.58

5509. On the activation of the oxide coated cathode. T. Arizumi and S. Narita. *J. Phys. Soc. Japan*, **6,** 15–20 (*Jan.–Feb.*, 1951).

The activation of oxide cathodes poisoned with O_2 was studied. In the first experiments only the surface was poisoned and the activation is assumed to be due to the diffusion of free Ba from the bulk of the oxide to the surface layers and the resulting increase in the density of impurity centres. This yields an activation energy of diffusion of 0·75 eV and a diffusion coefficient of 4×10^3 cm^2/sec. Then the cathode was completely poisoned and the rate of increase of activity and conductivity measured. For low activities $i \propto t$, for higher $i^2 \propto t$, confirming the presence of frozen holes. The activation energy for transferring a Ba atom from a lattice site to an impurity centre is 3·9 eV, while the dissociation energy is 4·1 eV. A. H. W. BECK

537.583 : 537.311.33

5510. Thermionic emission from thin semi-conducting films. K. B. Tolpigo. *J. Tech. Phys., USSR*, **19,** 1301 (*Nov.*, 1949) *In Russian.*

537.583 : 537.525.5

5511. Spectroscopic investigation of the behaviour of oxide cathodes in gaseous discharges. E. Krautz. *Z. Naturforsch.*, **6a,** 16–24 (*Jan.*, 1951).

Describes a spectroscopic technique for studying processes occurring at oxide-coated cathodes in l.p. gas discharges over the spectral range 2 200–7 600 Å. Studies were made, for example, of the discharge spectra (showing lines from the electrode material) with pure alkaline earth, and with compound cathodes to which metallic oxides had been added, and showed the build-up of atomic surface layers on the cathode. The technique, it is suggested, may be applicable to work on the control of surface layer formation and on poisoning and vaporization effects with oxide-coated cathodes. Spectra are shown for Hg/A tube fillings with Ba/Sr oxide, Ba oxide, Ba/Sr/Ca oxide and Ba/Ca/W/Th oxide cathode coatings. J. D. CRAGGS

537.583 : 621.385.833

5512. On a new high current electron gun with an indirectly heated tungsten cathode. E. B. Bas-Taymaz.

Diss. E.T.H., Zürich, No. 1813, 73 *pp.* (1950); also in *Mitt. Inst. Tech. Phys. E.T.H., Zürich, No.* 1. *In German.*

An electron gun for microscopes or diffraction cameras is described in which the emitting part of the cathode is the plane end of a W cylinder surrounded by a heating coil. Since it is not practicable to obtain enough heat by radiation, the cathode is partially heated by electron bombardment from the coil. The heater current and bombarding current are both pulsed, the main electron beam being cut off during the "on" period of these pulses. The temperature distribution is calculated in detail and the mechanical problem of supporting the W cylinder is discussed. The pulse generators are also described. The complete gun uses the lens system due to Law [*Proc. Inst. Radio Engrs*, **25**, 954–76 (*Aug.*, 1937)]. Experimental variations in the immersion lens were made to obtain optimum performance. A. H. W. BECK

537.585

5513. Life-time of potassium ions on a tungsten filament at 1 460°K. T. H. BULL AND D. G. MARSHALL. Letter in *Nature, Lond.*, **167**, 478 (*March* 24, 1951).

COSMIC RAYS 537.591

537.591.08

5514. Cosmic ray radiosonde and telemetering system. M. A. POMERANTZ. *Electronics*, **24**, 88–92 (*April*, 1951).

A description is given of the equipment carried by radiosonde balloons used in cosmic-ray research at 100 000 ft and of the ground-based receiving and recording apparatus. The airborne Geiger–Müller counter triggers a multivibrator which keys a u.h.f. transmitter. Received c.w. pulses suppress the hiss of a superegenerative receiver and a signal converter operates a recording oscillograph. Altitude and temperature are indicated by modulation intervals and frequency. Details of the organization of a field investigation are given. C. A. HOGARTH

537.591.1

5515. Note on soft gamma-component of cosmic rays. F. G. REST, L. REIFFEL AND C. A. STONE. Letter in *Phys. Rev.*, **81**, 894 (*March* 1, 1951).

A thin-walled Cu counter completely surrounded by an anticoincidence screen of similar counters detected photons of energy less than about 4 MeV. The omnidirectional flux of such photons at 30 000 ft is $3{\cdot}4\ \text{cm}^{-2}\ \text{sec}^{-1}$. J. G. WILSON

537.591.1

5516. The momentum spectrum and positive excess of cosmic ray mesons at sea-level. D. E. CARO, J. K. PARRY AND H. D. RATHGEBER. *Aust. J. Sci. Res. A*, **4**, 16–35 (*March*, 1951).

A spectrometer for momentum measurements on cosmic-ray particles is described. Charged particles are deflected in the air gap of an electromagnet and the deflection is recorded by an array of counters. The momentum distribution and positive excess of particles which penetrate 10 cm of Pb were determined over a momentum range $2{\cdot}4\times10^8$ to 5×10^{10} eV/c from measurements on 6 056 particles. A.

537.591.1

5517. Distribution in the atmosphere of cosmic-ray meson and electron components. P. CALDIROLA AND P. GULMANELLI. *Nuovo Cim.*, **8**, 229–42 (*April*, 1951) *In Italian.*

Starting from the assumption of the existence at the limit of the atmosphere of a primary radiation consisting of protons having an integral energy spectrum proportional to E^{-8} and assuming a model for the "plural" creation of mesons suggested in a preceding paper [Abstr. 3250 (1950)], a calculation is made on the distribution law in the atmosphere for slow mesons, fast mesons and electronic component. For this purpose the contribution of neutretto decay, μ-meson decay and knock-on processes are considered. The results obtained, shown in figures, are compared with experimental data. A.

537.591.1

5518. On the proton component of the vertical cosmic-ray beam at sea level. M. G. MYLROI AND J. G. WILSON. *Proc. Phys. Soc., Lond. A*, **64**, 404–17 (*April*, 1951).

Approximately 1% of the vertical cosmic-ray intensity at sea level is shown to consist of protons. These form a momentum spectrum of index $-2{\cdot}8$ in the range $10^3\ \text{MeV/c} < p < 5\times10^3\ \text{MeV/c}$ and have an absorption range in lead, $160 \pm 40\ \text{g. cm}^{-2}$. Using existing measurements at high altitude, the attenuation in the atmosphere of protons in the spectral region investigated is found to take place with a range $140 \pm 10\ \text{g. cm}^{-2}$. There is no negatively charged component of strong nuclear interaction in the vertical beam of intensity as great as 0·1% of the whole beam. A.

537.591.1

5519. Further measurements of the charge ratio of μ-mesons at sea level. B. G. OWEN AND J. G. WILSON. *Proc. Phys. Soc., Lond. A*, **64**, 417–24 (*April*, 1951).

Extended measurements of the charge ratio (positive/negative) or near-vertical μ-mesons at sea level show that it increases with meson momentum from about 1·17 at 10^3 MeV/c up to about 1·26 at 4×10^3 MeV/c. At higher momenta the statistical accuracy of the measured charge ratio is limited by the instrumental rate of collection, and it cannot yet be definitely decided whether the charge ratio decreases with increasing momentum, although the evidence now available favours a slow decrease. The general implications of the form of variation of charge ratio with momentum are indicated. A.

537.591.1

5520. The properties of particles producing high energy nuclear collisions in gold. M. B. GOTTLIEB. *Phys. Rev.*, **82**, 349–58 (*May* 1, 1951).

A large multiplate counter-controlled cloud chamber containing 300 g/cm² of Au has been used for the study of penetrating showers at an altitude of 11 500 ft. The minimum energy required to trip the counter control efficiently was about 15 BeV. Counters

located inside the chamber made it possible to observe events initiated by both ionizing and non-ionizing particles. It was found that at least 83·5% of the particles initiating these high energy events were ionizing. From the distribution of events in the plates of the chamber, the mean free path in Au for the particles producing these penetrating showers was found to be 145 ± 15 g/cm². The projected zenith angle distribution of the shower primaries could be approximately represented by $\cos^m \theta$, where m was in the range 8 to 10. Since the measurements were made at 680 g/cm² atmospheric depth, this corresponds to an absorption mean free path in air of 70 to 90 g/cm². The flux of particles capable of producing these high energy showers was found to be $(1\cdot7 \pm 1)\times 10^{-6}$ particles cm^{-2} sec^{-1} ster^{-1}. This value, when compared with the flux of the primary protons at the top of the atmosphere, yielded an absorption mean free path of 71 ± 5 g/cm². Application of the Gross transformation changed this value to 77 ± 5 g/cm². The large mass of the Au nucleus plus the presence of two mean free paths of material inside the chamber made it very unlikely that only a small fraction of the energy of the primary particles be lost in the cloud chamber. A.

537.591.1

5521. Nuclear interactions in gold of secondary particles emitted in penetrating showers. A. J. HARTZLER. *Phys. Rev.*, **82**, 359–72 (*May* 1, 1951).

A large counter-controlled cloud chamber containing 16 Au plates totalling 308 g/cm² in thickness was operated at an altitude of 11 500 ft. Forty of the pictures of penetrating showers obtained were selected for the determination of the mean free path for nuclear collisions of ionizing secondary particles. The result was found to be 230 ± 60 g/cm², corresponding to 0·7 ± 0·2 × the cross-section equal to the geometric area of the Au nucleus. The 14% of the nuclear events used in making this determination were large-angle scatterings of a penetrating secondary particle with no observable disintegration products emerging from the Au plate in which the scattering occurred. The number of secondary nuclear events occurring, which are not observed because of the absorption of all tertiary particles, was estimated to be 18% of the total. The momenta of the secondary particles used in this determination ranged between 10^9 and 10^{10} eV/c. The lowest energy penetrating shower which has a high probability of tripping the counter coincidence circuit used was estimated to be $1\cdot5\times10^{10}$ eV. The number of high energy protons among the secondary particles used in the determination of the collision mean free path was <11%, and the total fraction of protons is <30%. The 88 ± 3% of the penetrating showers observed in the experiment showed the presence of an observable electron cascade. The average number of penetrating secondaries of minimum ionization emitted in penetrating showers of an average energy of 3×10^{10} eV, and either not showing any electronic cascade or showing the presence of an electronic cascade having an energy less than or equal to 7×10^9 eV, is 7 ± 1 per shower. The corresponding average multiplicity of secondary particles of minimum ionization in penetrating showers of 6×10^{10} eV average energy, which show the presence of an electron cascade of an energy greater than 7×10^9 eV, is 11 ± 2 per shower. Evidence is given that the angular distribution of the mesons in the centre-of-mass system of a nucleon-nucleon collision at energies above $1\cdot5\times10^{10}$ eV is not isotropic and is probably collimated in two cones of about 50° half-angle around the directions of the velocities of the nucleons in the centre-of-mass system. A.

537.591.1

5522. The statistical interpretation of experiments on the absorption of shower particles. M. I. PODGORETSKIĬ. Letter in *J. Exp. Theor. Phys.*, **20**, 959–60 (*Oct.*, 1950) *In Russian.*

For a given number of incident, expressions are given for the mean number, and variance, of particles emerging from an absorber, which may be used in the interpretation of shower data. E. P. GEORG.

537.591.1

5523. The lateral and angular distribution of cascade showers. J. NISHIMURA AND K. KAMATA. Letter in *Progr. Theor. Phys.*, **5**, 899–901 (*Sept.–Oct.*, 1950).

The lateral structure functions of atmospheric cascade showers is computed for the cascade "approximation B" of Rossi and Greisen (asymptotic forms of radiation and pair processes, constant collision loss, Compton effect neglected). J. G. WILSON.

537.591.1

5524. Interpretation of the second maximum of Rossi curve. S. HAYAKAWA AND J. NISHURA. *Progr. Theor. Phys.*, **5**, 948–56 (*Nov.–Dec.*, 1950).

The second maximum is attributed to hard showers generated by the nucleon component. This is supported by detailed discussion of results of Kamedа and Miura [*Progr. Theor. Phys.*, **5**, 323 (*March–April*, 1950)]. Some difficulties remain. E. P. GEORG.

537.591.1

5525. The barometric coefficient of narrow air showers. J. HAMELIN AND M. SCHÉRER. *C.R. Acad. Sci., Paris*, **232**, 1089–91 (*March* 12, 1951) *In French.*

The barometric effect of these showers, detected by difference from extensive showers, is shown to be −5·6%/cm Hg at s.l., and is thus smaller than that of extensive showers. J. G. WILSON.

537.591.1

5526. The transition effect of extensive air showers. D. D. MILLAR. *Nuovo Cim.*, **8**, 279–88 (*April*, 1951).

Measurements have been made of the transition effect of the extensive air showers of cosmic rays in absorbers of Pb, Fe, C and water. The results indicate that the photons of the showers are predominantly of lower energies than are the electrons, and forms of the energy spectra for the two components incident on the counter trays are deduced. The discrepancy between the absorption of the showers in air and in local absorbers of similar atomic weight, such as C and water, is briefly discussed. A.

537.591.1

5527. On some recent calculations on cascade shower theory. H. MESSEL. Letter in *Phys. Rev.*, **82**, 259 (*April* 15, 1951).

The applicability of the results of the cascade computations (including ionization loss) of Bhabha

and Chakrabarty, Snyder and Bernstein are examined. The results of B. and C. appear to be more accurate than had been supposed. J. G. WILSON

537.591.15

5528. Angular distributions of shower particles as a function of depth. L. EYGES AND S. FERNBACH. Letter in *Phys. Rev.*, **82,** 287 (*April* 15, 1951).

537.591.15

5529. Radial distribution of shower electrons as a function of depth. S. FERNBACH. Letter in *Phys. Rev.*, **82,** 288 (*April* 15, 1951).

537.591.15

5530. On the absorption of penetrating showers. H. A. MEYER, G. SCHWACHHEIM AND A. WATAGHIN. *Phys. Rev.*, **82,** 424–7 (*May* 1, 1951).

Several experiments on the absorption in Pb of the particles of penetrating showers have been performed under different geometrical conditions. The penetrating showers produced in air are shown to have a high penetrating power, whereas those produced locally are strongly absorbed. An interpretation is given by the study of the selection of the penetrating showers by the apparatus. The cross-section for nuclear absorption of the π-mesons of the locally produced penetrating showers was measured and shown to be smaller than half the geometrical one. Some data on the structure of the penetrating showers and on the presence of photons were obtained. A.

537.591.15

5531. Counter observations of nuclear bursts. A. DAUDIN, J. DAUDIN AND R. ROBLEY. *C.R. Acad. Sci., Paris,* **232,** 1197–9 (March 19, 1951) *In French.*

The efficiency of a system of counters separated in a large mass of Pb for responding only to the N component, has been determined at s.l. and at 2 860 m altitude. The same arrangements indicate a barometric coefficient of 10·7%/cm Hg for the N component. J. G. WILSON

537.591.2

5532. A new method of determining the charge and energy of heavy nuclei in the cosmic radiation. A. D. DAINTON, P. H. FOWLER AND D. W. KENT. *Phil. Mag.*, **42,** 317–32 (*April*, 1951).

These may be determined from the frequency of the accompanying delta rays and the multiple scattering in its path through an emulsion. The method is illustrated by the charge spectrum of 226 tracks in emulsions exposed at 95 000 ft. A.

537.591.5

5533. Photographic emulsion studies of the latitude effect. K. R. DIXIT. *Indian J. Phys.*, **24,** 501–6 (*Nov.*, 1950).

Nuclear emulsions exposed and studied under identical conditions except for a change of 39° in the magnetic latitude show a significant difference of about 43% in the number of single tracks ($> 100\ \mu$). The experiments appear to suggest that the causes which produce the stars and the singles ($> 100\ \mu$) at an altitude of 2 200 m are independent of one another. A.

537.591.5

5534. Fine structure in the east-west cosmic-ray intensity at Lahore ($\lambda = 22°$ N), India. I. OM PARKASH. *Indian J. Phys.*, **24,** 513–21 (*Nov.*, 1950).

A triple coincidence telescope consisting of three internally quenched G.M. counters has been employed. The intensity measurements have been made in both the eastern and western azimuths from 0–42° at 6 degree steps. The results indicate a possibility of the existence of the negative primaries. The presence of silicon band (13·2 BeV) in the primary cosmic-rays is definitely shown, its edge extending to about 21° in the east of the zenith. A comparison between our results and those of Schremp and Banos, at Mexico ($\lambda = 29°$N), shows a striking similarity as regards the west-east excess. A.

537.591.5

5535. The latitude effect of cosmic-ray neutrons. W. P. STAKER, M. PAVALOW AND S. A. KORFF. Letter in *Phys. Rev.*, **81,** 889–90 (*March* 1, 1951).

Balloon measurements up to 62 000 ft in 69°N geomagnetic latitude show a neutron intensity reaching, at the maximum (56 000 ft), a value twice that in 54·7°N lat. J. G. WILSON

537.591.5

5536. The altitude and latitude variation in the rate of occurrence of nuclear disintegrations produced in the stratosphere by cosmic rays. J. J. LORD. *Phys. Rev.*, **81,** 901–9 (*March* 15, 1951).

The variation with altitude of the rate of production of stars in photographic plates was measured from mountain elevations to 94 000 ft at geomagnetic latitude $\lambda \simeq 54°$N. The type of particle initiating each star was determined and showed that the total flux of star-producing protons decreased rapidly from 94 000 ft to 11 500 ft and was compatible with an absorption mean free path (m.f.p.) of 145 g/cm^2. The total flux of star-producing neutrons showed a maximum near 70 000 ft and then decreased with altitude with an absorption m.f.p. of 170 g/cm^2. Similar altitude-dependence measurements were made at $\lambda \simeq 28°$N and showed that the rate of production by neutrons of stars of 3 to 9 prongs at 94 000 ft was 0·19 of the corresponding value at $\lambda \simeq 54°$. This demonstrates that 81% of the small stars at $\lambda \simeq 54°$ must be due to the primary particles of the cosmic radiation in the energy intervals given by the geomagnetic cut-off at $\lambda \simeq 28°$ and $\lambda \simeq 54°$ (1 to 8 BeV for protons, and for α-particles and heavy nuclei 0·35 to 3·5 BeV per nucleon). The total flux of star-producing protons varies by a factor of 3·0 between these two latitudes at 94 000 ft and shows that 67% of the proton-initiated stars at $\lambda \simeq 54°$ are due to primary particles of the energies given above. A.

537.591.8

5537. On the production of cosmic ray mesons. Y. FUJIMOTO, H. FUKUDA, S. HAYAKAWA AND Y. YAMAGUCHI. *Progr. Theor. Phys.*, **5,** 669–81 (*July–Aug.*, 1950).

Some kinematical relations are given connecting the description of meson production in c.m. and lab. co-ordinates. An extension of the meson production theory of Lewis *et al* [Abstr. 1152 (1948)] is

compared with other theories proposed. The experimental data available on meson showers is analysed and some criticism of earlier interpretations is given. On this basis, the variation of the nature of meson production with incident energy is outlined. R. H. DALITZ

537.591.8

5538. High energy nuclear evaporation. Y. FUJIMOTO AND Y. YAMAGUCHI. *Progr. Theor. Phys.*, **5**, 787–99 (*Sept.–Oct.*, 1950).

A detailed study on the basis of Weisskopf's evaporation theory [V. F. Weisskopf, *Phys. Rev.*, **52**, 295 (1937)] extending previous calculations [V. Fujimoto, Y. Yamaguchi, Abstr. 5097 (1950)] to include α-particle emission and estimates of fluctuations in the numbers of particles emitted. The numbers of neutrons, protons and α-particles evaporated are given explicitly for selected values of the excitation energy from 50 to 800 MeV. The relative number of α's seems to be too low (factor ~ 2) compared to values from cosmic-ray stars, but explanations are suggested. W. J. SWIATECKI

537.591.8

5539. Cosmic-ray underground. III. S. HAYAKAWA, K. MANO AND T. MIYAZIMA. *Progr. Theor. Phys.*, **5**, 844–8 (*Sept.–Oct.*, 1950).

For previous part, see Abstr. 5934 (1950). The zenith angle variation and, briefly, the temperature coefficient, of cosmic ray intensity at great depths is examined. On the assumption that surviving π-mesons are rapidly absorbed in the ground and that the effects at great depths depend entirely on μ-mesons, then in existence, which lose energy only by ionization, pair production and radiation, the zenith angle variation is shown to be closely represented by $\cos n\theta$, where $n = 1{\cdot}8$ at 200 m.w.e. and $2{\cdot}4$ at 1 700 m.w.e. The discrepancy between the latter value and the experimental $3{\cdot}1 \pm 0{\cdot}1$ (for small θ) is explicable by an additional nuclear cross-section of μ-mesons of the order 10^{-5} barn per nucleon. J. G. WILSON

537.591.8

5540. On the effect of the γ-ray to the cosmic ray underground. S. OGAWA AND S. MIURA. Letter in *Prog. Theor. Phys.*, **5**, 897–8 (*Sept.–Oct.*, 1950).

Underground stars are attributed to the action of π-mesons produced by the γ-rays of the soft component. E. P. GEORGE

537.591.8

5541. Interaction mean free path of the particles emitted in cosmic ray nuclear explosions. A. LOVATI, A. MURA, C. SUCCI AND G. TAGLIAFERRI. *Nuovo Cim.*, **8**, 271–8 (*April*, 1951).

The measurements of the interaction mean free path of the near minimum ionizing particles emitted in cosmic-ray nuclear explosions are discussed. A new determination of this mean free path has been made at mountain altitude, using a counter controlled cloud chamber containing thin Pb foils. The result is $200 \pm 25\%$ g cm^{-2} Pb. A.

537.591.8

5542. Rate of production of neutrons in ice by cosmic rays. S. LATTIMORE. *Phil. Mag.*, **42**, 331–7 (*April*, 1951).

It is shown that the number of fast neutrons produced at any point in ice is approximately proportional to the number of cosmic ray stars at that point. The results are compared with those of other investigations, and it is pointed out that many previous results are too low due to the misuse of a formula given by Bethe *et al.* [*Phys. Rev.*, **57**, 573 (1940)]. A.

537.591.8

5543. Cosmic-ray nucleon–nucleon collisions in photographic emulsions. E. PICKUP AND L. VOYVODIC. Letter in *Phys. Rev.*, **82**, 265 (*April* 15, 1951).

Four events in G.5 emulsion at 85 000 ft show only relativistic particles. The formation of these events by collision with protons and alternatively, with heavy nuclei, is discussed. J. G. WILSON

537.591.8

5544. Emulsion studies of cosmic-ray stars produced in metal foils. I. BARBOUR. Letter in *Phys. Rev.*, **82**, 280 (*April* 15, 1951).

Metal foils are sandwiched between two G.5 emulsions which after processing are put back in registration. The cross-section of star production is examined as a function of atomic number of foil ($13 \ll Z \ll 79$) and of star size. In particular, comparison with emulsion exhibits clearly the role of lighter elements in star formation in emulsions. J. G. WILSON

537.591.8

5545. Ionization chamber bursts at high altitudes. T. COOR, JR. *Phys. Rev.*, **82**, 478–85 (*May* 15, 1951).

A thin-walled, low-pressure ionization chamber has been sent into the upper atmosphere by means of balloons to study bursts of ionization. Pulse size, barometric pressure and temperature were telemetered to the ground by means of a f.m. audio sub-carrier system with a 75-Mc/s radio link. Measurements have been made of the size and frequency of bursts of ionization greater than that produced by $0{\cdot}8$ Po alpha-particles ($0{\cdot}8 \times 5{\cdot}1 = 4{\cdot}1$ MeV) at altitudes up to that corresponding to an air mass of 17 g/cm^2 remaining overhead. A.

537.591.8 : 539.18

5546. The reciprocity principle and the masses of varitrons. G. S. GORDADZE. Letter in *J. Exp. Theor. Phys.*, **20**, 767–8 (*Aug.*, 1950) *In Russian.*

Some numerical values calculated from Born's theory are compared with figures given by Alikhanov *et al.* E. P. GEORGE

537.591.8 : 539.18

5547. Concerning the origin of secondary slow mesons in the atmosphere. A. ABDULLAEV, G. ZHDANOV, YU. KAMENETSKIĬ, A. NAUMOV AND A. KHAĬDOROV. *J. Exp. Theor. Phys.*, **20**, 673–83 (*Aug.*, 1950) *In Russian.*

Delayed coincidences in the lower of 3 banks of Geiger counters were recorded. The transition curve and +/− ratio of slow μ-mesons were studied by using absorbers of various thickness and Z between the counters. Various hypotheses concerning the origin of the mesons are discussed. It is concluded that they are derived from the decay of heavier mesons with shorter lifetimes. E. P. GEORGE

MAGNETISM 538

538.1/.2

5548. Recent ideas and experiments in magnetism. I. L. F. BATES. *Proc. Instn Elect. Engrs, Pt I*, **97**, 340–50 (*Nov.*, 1950).

A review article dealing with recent powder pattern experiments, the relevant theoretical work of Néel and the theory of coercivity. E. P. WOHLFARTH

538.113

5549. Nuclear magnetic resonance absorption in $NaSbF_6$. E. R. ANDREW. Letter in *Phys. Rev.*, **82**, 443 (*May* 1, 1951).

A theoretical interpretation of the anomalous line width of Sb resonance of $NaSbF_6$/HF in solution is given in terms of a polymeric chain with rapid reorientation of the SbF_6 octahedron about only one of its tetrad axes. D. H. WHIFFEN

538.114

5550. Statistics of the three-dimensional ferromagnet. II. T. OGUCHI. *J. Phys. Soc. Japan*, **6**, 27–31 (*Jan.–Feb.*, 1951).

Abstr. 8117 (1950) part I; see also Abstr. 1068 (1950), 2822 (1951). Using the Ising model the partition function is determined in the form of a power series in β, valid at low temperatures ($\beta = \exp(-J/kT) \ll 1$, where J is the exchange integral). Hence the spontaneous magnetization and correlation probabilities are calculated, the latter both for simple and more complicated configurations. E. P. WOHLFARTH

538.114

5551. Statistics of the three-dimensional ferromagnet. III. T. OGUCHI. *J. Phys. Soc. Japan*, **6**, 31–5 (*Jan.–Feb.*, 1951).

The partition function is expressed as a power series in $\kappa = \tanh J/2kT$, valid at high temperatures. Hence the paramagnetic susceptibility and correlation probabilities are calculated. E. P. WOHLFARTH

538.114

5552. Antiferromagnetism. R. STREET. *Sci. Progr.*, **39**, 258–82 (*April*, 1951).

Review of theory, showing that the various types of magnetic behaviour may be brought into the general scheme of exchange interaction. 15 refs.

538.114

5553. On the theory of antiferromagnetism. I. Itinerant electron model. N. TSUYA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 387–91 (*Dec.*, 1949).

A general theory based on the energy band concept. With numerous undetermined parameters available, agreement with experiment is attained for MnSe. E. P. WOHLFARTH

538.114

5554. A note on the ground state in antiferromagnetics. J. M. LUTTINGER. *Phys. Rev.*, **81**, 1015–18 (*March* 15, 1951).

The lowest state of an antiferromagnetic substance is investigated by using the Ising model for the spins. By means of a method of Luttinger and Tisza it is found possible to derive earlier results of Anderson very simply. A.

538.114

5555. Collective electron ferromagnetism: rectangular energy bands. E. P. WOHLFARTH. *Phil. Mag.*, **42**, 374–90 (*April*, 1951).

Calculations similar to those of Stoner [*Proc. Roy. Soc. A*, **165**, 372 (1938)] are carried out for an energy band for which the energy density of states is constant. These have a bearing on calculations of the actual band form for nickel [*Phil. Mag.*, **42**, 106 (*Jan.*, 1951)]. After brief reference to previous work and a statement of the basic assumptions of the treatment, relations are derived giving the dependence on temperature and the interchange interaction energy of the spontaneous magnetization below and the susceptibility above the Curie point. Various explicit limiting relations are deduced, and numerical results are given. Formulae are also derived which give the internal energy and specific heat over the whole temperature range. Relations are given for the most important experimentally observable thermal characteristics, such as the specific heat discontinuity at the Curie point. Experimental results which are briefly discussed include those on the magnetic properties of Ni and its alloys and the thermal properties of Ni, including the energy and specific heat characteristics, the temperature-variation of specific heat and the magneto-caloric effect. The high temperature specific heat of paramagnetics is also discussed. Certain results for an energy band of more general form are given. A.

538.122

5556. The orientation of paramagnetic and diamagnetic rods in magnetic fields. A. R. LAUFER. *Amer. J. Phys.*, **19**, 275–9 (*May*, 1951).

It is commonly believed that a paramagnetic rod will align itself with an impressed magnetic field and that a diamagnetic rod will set its long dimension across the field. The present paper shows that this conception is not generally valid. In a strictly uniform field both paramagnetic and diamagnetic rods will set themselves parallel to the field. In a non-uniform field the orientation of each of these rods will depend upon the particular configuration of the field. A.

538.22

5557. Nuclear resonance in flowing liquids. G. SURYAN. *Proc. Indian Acad. Sci. A*, **33**, 107–11 (*Feb.*, 1951).

The experiments afford a striking demonstration of the effects of finite relaxation time and afford a method of measuring relaxation times directly. A.

538.22

5558. Magnetic properties of mixed magnesium–zinc ferrites. C. GUILLAUD. *C.R. Acad. Sci., Paris*, **232**, 944–6 (*March* 5, 1951) *In French.*

Measurements were made of the saturation moment, Curie temperature and magnetization, temperature curves of simple and mixed ferrites having the general formula $(Fe_2^{3+}Mg_x^{2+}Zn_{(1-x)}^{2+})O_4^{2-}$. Particular attention

was paid to the influence on the magnetic properties of the conditions of the previous thermal treatment. E. P. WOHLFARTH

538.22

5559. Thermo-remanence of small disperse magnetite particles. J. ROQUET. *C.R. Acad. Sci., Paris*, **232**, 946–8 (*March* 5, 1951) *In French.*

Measurements were made of the mass susceptibility and the field variation of the thermo-remanent magnetization of kaolin mineral specimens containing about 1% of artificial magnetite particles having sizes of about 0·1 μ. E. P. WOHLFARTH

538.22

5560. Ferromagnetic domains in bicrystals of nickel. U. M. MARTIUS, K. V. GOW AND B. CHALMERS. Letter in *Phys. Rev.*, **82**, 106–7 (*April* 1, 1951).

538.22

5561. Magnetic effects and the Hartree–Fock equation. J. C. SLATER. *Phys. Rev.*, **82**, 538–41 (*May* 15, 1951).

The Hartree–Fock equations state that each electron in an atom or molecular system should move in a different potential. In some cases, particularly magnetic cases, this leads to important consequences, since electrons with opposite spins move in different potentials. In particular, in an antiferromagnetic substance, electrons of + and − spin have different potentials; and for an electron of + spin, for instance, the potential energy is lower in those atoms whose spins are pointed in the + direction than in those with the opposite spin. This results in a periodic perturbation of potential, with periodicity twice the atomic periodicity, and leads to a splitting of each energy band in half, with a gap in the middle. In a case where the energy band was half full, resulting in a conductor: disregarding this effect, the resulting half-band will be just filled when it is considered this may explain the insulating nature of some antiferromagnetics. A similar argument applied to a diatomic molecule like H_2 can result in two alternative types of solutions of the Hartree–Fock equations: one leading to atomic orbitals, the other to molecular orbitals. The solution with atomic orbitals shows an analogy to the antiferromagnetic problem; that with ordinary molecular orbitals shows an analogy to the band theory of a non-magnetic conductor. A.

538.22 : 538.55

5562. Measurements on ferrite cores of high permeability. M. KORNETZKI. *Z. angew. Phys.*, **3** (*No.* 1) 5–9 (1951) *In German.*

A general discussion of the use of ferrite materials as transformer etc. cores. Measurements (by J. Frey) are reported, showing that permeabilities up to 3 500 may be attained, which are almost independent of the frequency up to a limiting value (determined by the Larmor effect) of about 1–6 kc/s. In some cases capacitative eddy currents produce a resonance effect. Experiments were also carried out on the temperature and field dependence of the permeability of several Ni–Zn ferrite specimens. It was found that the Curie temperature is in general in an inverse relation to the permeability. E. P. WOHLFARTH

538.22 : 538.5

5563. The magnetization process in ferrites. J. WENT AND H. P. J. WIJN. Letter in *Phys. Rev.*, 8 269 (*April* 15, 1951).

Initial magnetization curves for some Mn, Ni an Zn ferrites having high values of initial permeabili were determined at different frequencies. It is foun that, apart from a frequency-independent proces an additional process is operative near the coerciv field, giving rise to a permeability which is frequency dependent even below the gyromagnetic resonanc frequency. This process is ascribed to irreversibl domain boundary movements. E. P. WOHLFART

538.22 : 538.5

5564. Magnetic resonance absorption in anti ferromagnetic materials. T. OKAMURA, Y. TORIZUK AND Y. KOJIMA. Letter in *Phys. Rev.*, **82**, 285 (*April* 1 1951).

Resonance absorption peaks and line widths wer measured for MnS, MnO and MnSe at temperature both above and below the Curie point. The peak were found to increase in height and the line width to decrease with increasing temperatures; the max mum resonance field (3 510 oersted) occurs a 9 311 Mc/s for all the samples. E. P. WOHLFARTH

538.22 : 539.2

5565. Polymorphism of the compound MnBi at th temperatures of disappearance and reappearance of th spontaneous magnetization. C. GUILLAUD. Letter i *J. Phys. Radium*, **12**, 143 (*Feb.*, 1951) *In French.*

A sudden decrease of the lattice parameter *c* from 6·11 Å to 5·83 Å was observed as MnBi passes from the ferromagnetic to, it is believed, the antiferro magnetic state at 360°C. E. P. WOHLFARTH

538.22

5566. Resonance in antiferromagnetics. K. W. HI STEVENS. Letter in *Phys. Rev.*, **81**, 1058 (*March* 15 1951).

An explanation of the disappearance of microwave resonance signals in antiferromagnetics below the Curie temperature. See Abstr. 490 (1951).

538.221 : 536.63

5567. The behaviour of Fe–Al, Fe–Si and Fe–Al–Si alloys considered from the standpoint of the ferro magnetic superlattice. H. SATO AND H. YAMAMOTO *J. Phys. Soc. Japan*, **6**, 65–6 (*Jan.–Feb.*, 1951).

Reports measurements of the specific heat a dependent on temperature for a series of ternary alloys $Fe_3Al_{1-x}Si_x$. The order-disorder and ferro magnetic transition temperatures are determined and the characteristics of the respective λ-points examined. E. P. WOHLFARTH

538.221 : 539.18

5568. Magnetic structure of magnetite and its use in studying the neutron magnetic interaction. C. G SHULL, E. O. WOLLAN AND W. A. STRAUSER. Letter in *Phys. Rev.*, **81**, 483–4 (*Feb.* 1, 1951).

It is shown by neutron diffraction that Fe_3O_4 is ferrimagnetic. The 111 reflection arises almost wholly from magnetic scattering and its intensity is

ery sensitive to the direction of magnetization. Quantitatively the results agree with the Schwinger–Halpern–Johnson theory. J. THEWLIS

538.221 : 539.26

5569. Crystal structure transitions in antiferromagnetic compounds at the Curie temperature. J. S. SMART AND S. GREENWALD. Letter in *Phys. Rev.*, **82**, 13–14 (*April* 1, 1951).

An earlier discussion [Abstr. 492 (1951)] is extended. E. P. WOHLFARTH

538.221 : 621.318.2/.3

5570. On the utilization of Foucault currents for the study of ferromagnetic substances. I. EPELBOIN. *Rev. Gén. Elect.*, **60**, 74–84 (*Feb.*, 1951) *In French.*

Foucault (eddy) currents are expressed, for homogeneous material, by the introduction of a complex permeability, and the application to heterogeneous material is discussed. It is shown that a study of the Foucault currents, in conjunction with electrolytic polishing, can lead to information of the macroscopic magnetic structure. J. R. MADDOX

538.222

5571. Note on the adiabatic demagnetization of cobalt ammonium sulphate. B. BLEANEY. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 316–17 (*March*, 1951).

The h.f.s. of this salt can be responsible for only a small part of its anomalous magnetic behaviour below 0·1°K. L. PINCHERLE

538.222

5572. Hyperfine structure in paramagnetic salts and nuclear alignment. B. BLEANEY. *Phil. Mag.*, **42**, 441–8 (*May*, 1951).

Abragam and Pryce [Abstr. 2821 (1951)] have shown that the hyperfine structure in paramagnetic salts can be interpreted using a simple Hamiltonian involving components of the electron and nuclear spins. On the basis of this Hamiltonian, general formulae are given for the allowed transitions in strong magnetic fields, assuming that the paramagnetic ions have axial symmetry and that interactions with the electric quadrupole moment of the nucleus are small compared with those involving the magnetic dipole moment. As far as possible, general formulae are also given for the energy levels in zero magnetic field, and the allowed transitions are indicated. The use of hyperfine structure in paramagnetic salts for the production of nuclear alignment is discussed, with some quantitative data. A.

538.222

5573. Note on the magnetic resonance absorption in paramagnetic salts. K. YOSIDA. Letter in *Progr. Theor. Phys.*, **5**, 1047–9 (*Nov.–Dec.*, 1950).

The magnetic resonance lines for $CuSO_4 . 5\,H_2O$, $CuK_2Cl_4 . 2\,H_2O$, $Cu(NH_4)_2Cl_4 . 2\,H_2O$ do not separate unless a very short wavelength (c. 1 cm) is used. A wave-mechanical explanation for this effect is proposed. W. R. ANGUS

538.222

5574. On the paramagnetic displacement of the nuclear resonance frequency. P. GRIVET AND Y. AYANT. *C.R. Acad. Sci., Paris*, **232**, 1094–6 (*March* 12, 1951) *In French.*

A discussion of various factors that may influence magnetic shielding. L. PINCHERLE

538.222

5575. An absolute measurement of the susceptibility of tantalum and other metals. F. E. HOARE AND J. C. WALLING. *Proc. Phys. Soc., Lond. B*, **64**, 337–41 (*April*, 1951).

Mass susceptibility $\chi_{Ta} \times 10^6 = 0{\cdot}8490 \pm 0{\cdot}0006$ at 20°C. Small specimens of Ta have been used to determine, by a comparative method, the susceptibilities of specimens of Pt, Pd and Rh at 20°C. The values obtained are: $\chi_{Pt} \times 10^6 = 0{\cdot}9712 \pm 0{\cdot}0007$, $\chi_{Pd} \times 10^6 = 5{\cdot}231 \pm 0{\cdot}004$, $\chi_{Rh} \times 10^6 = 0{\cdot}9903 \pm 0{\cdot}0008$. All specimens were prepared from spectrographically standardized materials. A.

538.222

5576. The theory of the nuclear hyperfine structure of paramagnetic resonance spectra in the copper Tutton salts. A. ABRAGAM AND M. H. L. PRYCE. *Proc. Roy. Soc. A*, **206**, 164–72 (*April* 10, 1951).

The general theory of a previous paper [Abstr. 2821 (1951)] is applied to the copper Tutton salts. It is found that unless account is taken of the effect of admixed configurations containing unpaired *s*-electrons, agreement with experiment is impossible. Allowance for unpaired *s*-electron configurations gives good agreement, both for anisotropy and magnitude of the effect. The effect of the nuclear quadrupole moment, though small, is important, and the paramagnetic resonance method is in principle perhaps capable of giving a more accurate value of this nuclear constant than optical methods. A.

538.222

5577. The theory of paramagnetic resonance in hydrated cobalt salts. A. ABRAGAM AND M. H. L. PRYCE. *Proc. Roy. Soc. A*, **206**, 173–91 (*April* 10, 1951).

The theory of a previous paper [Abstr. 2821 (1951)] is applied to the paramagnetic resonance of certain cobalt salts. The splitting of the orbital levels by the crystalline field is first investigated, and then the further splitting by the spin-orbit interaction. The *g*-values so derived are in good agreement with experiment. The magnitude of the hyperfine splitting is also in good agreement. A.

538.222

5578. Magnetic properties of some paramagnetic crystals at low temperatures. B. C. GUHA. *Proc. Roy. Soc. A*, **206**, 353–73 (*May* 7, 1951).

The principal magnetic susceptibilities and anisotropies of a number of salts of the iron group have been measured from room temperature down to about 80°K. The results are discussed in the light of the crystalline field theory developed by Van Vleck, and Schlapp and Penney. A.

538.222

5579. Microwave resonance absorption in paramagnetic salts. YU TING AND D. WILLIAMS. *Phys. Rev.*, **82**, 507–10 (*May* 15, 1951).

Thirteen paramagnetic salts of the Fe group in powdered or crystalline form have been investigated

for their resonance absorption at microwave frequencies. Effective g-factors are obtained from the frequencies and magnetic field strengths at which absorption peaks occur. The effects on line shape from dipole–dipole and exchange interactions, and from the crystalline electric field, have been studied. A.

538.222

5580. The spin relaxation time of chromium alum. E. Ishiguro, K. Kambe and T. Usui. *Phys. Rev.*, **82**, 680–3 (*June* 1, 1951).

The theoretical expression for the spin relaxation time of CrK alum is derived when the static magnetic field is not present. This derivation makes use of the method of moments and assumes that the absorption line has a Gaussian shape. Calculation of the second moment takes into account, straightforwardly, the small crystalline splitting of the lowest orbital state of the Cr ion. The result is compared with the expression derived by Broer and with the experimental value. It is concluded that a small contribution of exchange interaction must be present. The estimation shows that the exchange constant A is about $4{\cdot}9\times10^{-19}$ erg. A.

538.222 : 536.48

5581. The magnetic behaviour of iron ammonium alum at very low temperatures. M. J. Steenland, D. de Klerk, M. L. Potters and C. J. Gorter. *Physica*, **17**, 149–60 (*Feb.*, 1951).

See Abstr. 232, 3267 (1950). The magnetic properties have been studied between about 0·005 and 0·05°K. The samples investigated were a sphere of powder and a massive prolate spheroid. No difference was found in the Curie point, which lies at about 0·030°K. A.

538.222 : 536.48

5582. Experiments with an anisotropic magnetic crystal at temperatures below 1°K. C. G. B. Garrett. *Proc. Roy. Soc. A*, **206**, 242–57 (*April* 10, 1951).

Magnetic cooling experiments on a spherical single crystal of cobalt ammonium sulphate are described. Measurements were made as functions of the absolute temperature between 1° and 0·05°K of (i) the specific heat, (ii) the principal magnetic susceptibilities, and (iii) the variations in susceptibility on applying (adiabatically) a steady parallel magnetic field. The measurements in the range from 1°K down to the Curie point are discussed in connection with the dipole–dipole, exchange and nuclear interactions in the crystal. Below the Curie point, for the K_1 axis only, an interesting effect was found, in that a steady field was observed to produce an increase in a.c. susceptibility instead of the usual decrease. At these temperatures the susceptibility was found to reach a fairly sharp maximum in a field of a few hundred gauss, and reasons are given for supposing that these maxima mark the boundary of the antiferromagnetic region. The experimental results are discussed in connection with Sauer and Temperley's model for the antiferromagnetic state at low temperatures. A possible explanation of the apparent absence of a first-order transition at lower temperatures, expected in the theory but not observed in practice, is also given. A.

538.222 : 541.

5583. On the paramagnetic properties of solut of iron and cobalt salts. Y. Ayant. *C.R. Acad. S Paris*, **232**, 1203–4 (*March* 19, 1951) *In French.*

The anomalous values of the magnetic mome of the ions Fe^{++} and Co^{++} are explained by assum that the irregular electric field E near the ion has each instant cylindrical symmetry. If H is at angle θ with E, the effective magnetic moment given by $\mu_{eff}^2 = 4S(S+1) + L^2$, a formula wh agrees with experiment within 1%. L. PINCHE

538.222 : 541.

5584. The magnetic field acting on an ion in aqueous solution of ferrous and cobaltous salts. Ayant. *C.R. Acad. Sci., Paris*, **232**, 1298–1 (*March* 28, 1951) *In French.*

The field is calculated from the paramagne properties of the ions (see preceding Abst Satisfactory agreement is reached with the val obtained from the displacement of the magne resonance frequency. L. PINCHE

538.2

5585. Diamagnetic properties of silicones. Pacault. *C.R. Acad. Sci., Paris*, **232**, 135 (*April* 2, 1951) *In French.*

The molar susceptibilities of 6 linear and 2 cyc silicones have been measured and a value of χ_{Si} -12×10^{-6} c.g.s. units deduced. W. R. ANG

538.224 : 536.

5586. The magnetic behaviour of copper potassi tutton salt at very low temperatures; a correction a an addition. M. J. Steenland, D. de Klerk, J. Beun and C. J. Gorter. *Physica*, **17**, 161–3 (*Fe* 1951).

See Abstr. 1870 (1950). An error of calculation.

538.2

5587. A precise mechanical measurement of gyromagnetic ratio of iron. G. G. Scott. *Phys. Re* **82**, 542–7 (*May* 15, 1951).

In this experiment the gyromagnetic ratio of sample of very pure Fe was determined. The samp was wound with a magnetizing coil and supported a torsional pendulum in an evacuated space almo completely free of residual magnetic fields. Chang in pendulum amplitude were brought about repeated and synchronized reversals of the magnetizi current. These changes were measured along wi corresponding changes in magnetic moment of t sample. The average value obtained for the gyr magnetic ratio was $1{\cdot}0278 \pm 0{\cdot}0014$ times the mas to-charge ratio of the electron.

538.2

5588. The domain structure of ferromagnet crystals. H. Lawton. *Rep. Brit. Elect. Res. As Ref. N/T*58, 8 *pp.* (1950).

An experimental study has been made of doma arrangements in a specimen cut from a single cryst of silicon iron, using the powder pattern techniqu A structure for a (100) [100] long rod of rectangul cross-section at the knee of the magnetization cur is suggested. The formation of powder patterns discussed.

538.245

5589. Domain wall movement in a single crystal. K. H. STEWART. *Rep. Brit. Elect. Res. Ass., Ref. N/T59*, 5 *pp.* (1950).

A "picture frame" specimen was cut from a single crystal of silicon iron such that all faces were parallel to the (100) planes of the lattice. It exhibited a large Barkhausen jump in the I–H curve. The speed of domain wall movement was measured and compared with that predicted theoretically. A.

538.245

5590. Dislocations, cavities and the approach to magnetic saturation. W. F. BROWN, JR. Letter in *Phys. Rev.*, **82**, 94 (*April* 1, 1951).

Answers criticisms by Néel and Stoner [see Abstr. 506 (1951)] of the author's discussion, by means of dislocation theory, of the origin of magnetic hardness. E. P. WOHLFARTH

538.248

5591. On the magnetic after-effect due to the irreversible displacement of domain boundaries. II. The dependence on temperature and tension. S. MAEDA. *J. Phys. Soc. Japan*, **6**, 60–4 (*Jan.–Feb.*, 1951).

The experiments on Cr–permalloy reported previously [Abstr. 1939 (1951)] are extended. The flux change after a time t, $B_n(t)$, is inversely proportional to t for all values of the temperature (− 50 to 200°c) and of the applied stress (0 to 8·3 kg mm^{-2}), but the characteristics of curves relating $B_n(t_0)$ ($t_0 = 0{\cdot}01$ sec) and the final field, H_f, are influenced by temperature and stress changes. The maxima in these curves are depressed both by an increase of temperature and of the applied stress. The observed phenomena are ascribed to irreversible domain boundary movements. E. P. WOHLFARTH

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

5592. Covariant canonical formalism of Maxwell's electrodynamics. J. L. LOPES. *An. Acad. Brasil Cienc.*, **22** (*No.* 4) 349–69 (1951) *In Portuguese.*

The theory is developed by analogy with quantum electrodynamics. Poisson brackets, Heisenberg and Schrödinger representations, are introduced in the classical theory. A Wentzel field of charge distribution is defined, which describes the system in the interaction representation. The classical theory of the electron is derived as a particular case. L. PINCHERLE

538.3 : 530.145

5593. On the e.m. field "orthogonal" in space-time. II. A. M. PRATELLI. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **9**, 331–6 (*Dec.*, 1950) *In Italian.*

Further properties, mainly of a geometrical nature, are derived for such fields [see Abstr. 3646 (1951)].

538.52

5594. The field induced by an oscillating magnetic dipole outside a semi-infinite conductor. A. N. GORDON. *Quart. J. Mech. Appl. Math.*, **4**, 106–15 (*March*, 1951).

Formulae are derived for the external field, and the normal component of the field induced by a circular alternating current filament at the surface of the conductor is considered. A.

538.52

5595. Electromagnetic induction in a uniform semi-infinite conductor. A. N. GORDON. *Quart. J. Mech. Appl. Math.*, **4**, 116–28 (*March*, 1951).

The currents induced by external magnetic or electric fields are studied systematically. A one-dimensional heat flow analogue is derived which enables the familiar methods developed in connection with heat conduction to be applied directly to the solution of corresponding problems in electromagnetic induction. A.

538.551 : 621.3.011

5596. A geometrical interpretation, in Hilbert space, of the properties of periodic or shock states. R. VALLÉE. *Ann. Télécommun.*, **6**, 61–6 (*March*, 1951) *In French.*

Relevant properties of Hilbert space are reviewed. The periodic current and potential established in a linear impedance are each represented by a vector in Hilbert space; and this permits an extension of Ohm's law, Joule's law and the notion of power factor. This extension is carried further so as to apply to a network of linear impedances. Similar results are obtained for shock states. L. S. GODDARD

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

5597. On the representation of wavefields. W. BRAUNBEK. *Z. Naturforsch.*, **6a**, 12–15 (*Jan.*, 1951) *In German.*

The notion of wave surfaces is discussed critically. It is shown that a representation of a wavefield by means of equiphase surfaces and the lines of the averaged energy flux is always possible in the case of scalar fields, but only for special classes of problems in the case of electromagnetic fields. In general there are no orthogonal surfaces to the Poynting vector lines. L. PINCHERLE

538.563 : 621–526

5598. A phase-sensitive detector circuit having high balance stability. N. A. SCHUSTER. *Rev. Sci. Instrum.*, **22**, 254–5 (*April*, 1951).

The inherently fixed balance of the circuit should make it useful in the many types of servo circuits which utilize phase detected error signals. It has been found to be particularly useful in nuclear resonance measuring circuits. A.

538.566 : 621.392.2

5599. A new solution of the fundamental problem of the propagation of electromagnetic waves along a set of conductors. N. A. BRAZMA. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 1) 41–4 (1951) *In Russian.*

Mathematical. Solutions $u(x, t)$ $i(x, t)$ of the generalized equations of telegraphy are sought, under the special boundary and initial conditions $u(0, t) = \text{const.}$, $u(1, t) = 0$; $u(x, 0) = 0$; $i(x, 0) = 0$.

J. JACOBS

538.566 : 621.392.2

5600. Note on the predetermination of the conditions of propagation of a high-frequency wave along a 3-phase symmetrical line connected between a conductor and earth, and whose other two terminals are loaded with equal impedances. A. CHEVALLIER. *C.R. Acad. Sci., Paris*, **232**, 490–1 (*Feb.* 5, 1951) *In French.*

538.566

5601. Diffraction of electromagnetic waves by a plane wire grating. J. SHMOYS. *J. Opt. Soc. Amer.*, **41**, 324–8 (*May*, 1951).

Previous work on diffraction by a wire grating is briefly reviewed. The problem of diffraction by a finite grating consisting of perfectly conducting wires of arbitrary cross-section is formulated in terms of characteristic plane waves corresponding to the various order spectra defined in optics. Scattering matrix elements are expressed as stationary functionals of current distribution on the grating wires, for the incident wave falling at right angles to the grating elements and polarized either parallel or perpendicular to them. These are evaluated for the thin wire grating and parallel polarization. A.

538.566 : 621.396.11

5602. On the diffraction of a plane electromagnetic wave by a paraboloid of revolution. C. W. HORTON AND F. C. KARAL, JR. *J. Appl. Phys.*, **22**, 575–81 (*May*, 1951).

The problem of the diffraction of a plane electromagnetic wave by the convex surface of a paraboloid of revolution is examined. Expressions for the components of the incident wave, the scattered wave, and the refracted wave are obtained and are written in such a form that boundary conditions can be satisfied over a paraboloidal surface $\xi = \xi_0$. The analysis is then restricted to the case of a perfectly conducting paraboloid and a wave whose wave front is perpendicular to the axis of rotation. The amplitude of the scattered wave is plotted as a function of the distance along the axis of rotation for 3 paraboloids. One of these curves is compared with the scattered field produced by a sphere whose radius is equal to the radius of curvature of the paraboloid at the nose.

A.

538.566 : 621.392.26 : 621.396.11

5603. Diffraction of electromagnetic centimetre-waves by metallic and dielectric disks. H. SEVERIN AND W. V. BAECKMANN. *Z. angew. Phys.*, **3** (*No.* 1) 22–8 (1951) *In German.*

The field distribution in front of metallic and dielectric disks is investigated experimentally. As a completely plane wave could not be established, t decrease of amplitude of the incident wave w measured and taken into account in the calculatio Two different methods were used for metallic disk and both gave the same result after correction for t fact that the incident wave was not completely plan The experiments on dielectric disks show that t reflected wave differs from that from a metallic di of the same form, only by a constant factor. Th factor is found to be equal to the reflection coefficie calculated by ordinary optical methods. K. JOHNSE

538.566 : 621.396.1

5604. Electromagnetic scattering from spheres wi sizes comparable to the wavelength. A. L. ADE *J. Appl. Phys.*, **22**, 601–5 (*May*, 1951).

By using suitably defined logarithmic derivati functions and the recurrence formulae due to Infel the problem of obtaining numerical answers for t scattering of a plane electromagnetic wave by a sphe can be simplified. This is particularly true if t sphere has a complex index of refraction. The natu of these logarithmic derivative functions is show for one special case involving water spheres. Exper mental results are given for the back-scattering cros sections of water spheres in the electrical size regio $0{\cdot}74 \leq 2\pi a/\lambda \leq 5{\cdot}90$. These results were obtaine at a wavelength of 16·230 cm using the standing-wav method of measurement. A

538.566 : 621.396.1

5605. On the diffraction of electromagnetic wave by two conducting parallel half-planes. M. G CHENEY, JR. AND R. B. WATSON. *J. Appl. Phys.*, **2** 675–9 (*May*, 1951).

An examination is made of the diffraction of radi waves produced by the edges of two parallel half planes, disposed one behind the other relative to th signal source. A number of experimental pattern are exhibited. Computed patterns are obtaine following a line of analysis formulated by Baker an Copson. Comparison between experiment and theor shows only fair agreement, indicating the need for a better theoretical approach. A

538.566 : 621.392.2

5606. On the propagation of electromagnetic wave in a conducting tube filled with a non homogeneous dielectric. D. GRAFFI. *Ann. Mat. Pura Appl.*, **30** 233–9 (1949) *In Italian.*

The tube is a rectangular waveguide, and the $TE_{m,0}$-waves are discussed. Limits are found for the lowest critical frequency; and if the frequency exceeds a certain amount, then several waves are possible. The group velocities are obtained.

MATHEMATICAL REVIEWS

538.566 : 621.392.2

5607. Stimulation of a spiral line. S. KH. KOGAN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 489–92 (1950) *In Russian.*

A mathematical demonstration of the theory that only one wave of current, with the propagation constant w_I, is transmitted along a wire of spiral form in the first two sections. J. CLEUGH

538.566 : 621.396.671

3. Reflecting surface to simulate an infinite ducting plane. S. J. RAFF. *J. Appl. Phys.*, **22**, -13 (*May*, 1951).

n measuring small microwave reflections back to transmitting aerial, a finite reflecting surface ch simulates the reflection of an infinite plane is rable for calibration. Treating a flat reflecting ace by the methods of physical optics, the reflec- can be represented as the sum of the contributions resnel zones. Owing to the slow rate of decrease eflections from successive zones, the shape of the ace has considerable effect on the accuracy with ch its reflection simulates that of an infinite plane. means of the calculus of variations, an optimum pe is designed which, for a given aerial pattern, ector size and range of aerial to reflector distances, give the closest simulation of the reflection of an nite plane. Such an optimum surface of 23 wave- gths extreme dimensions has been constructed for at 25 wavelengths from a dipole aerial. The maxi- m simulation error was calculated to be $\pm 3\%$. e reflection from this surface has been measured l is within $\pm 4\%$ of that of an infinite plane over range of 15 to 35 wavelengths from the aerial. A.

538.566.2

9. The propagation of e.m. waves in slightly erogeneous layers. G. ECKART. *C.R. Acad. Sci., -is*, **232**, 1294–6 (*March* 28, 1951) *In French.*

Formulae are given for the reflection coefficient at nsition layers between media of different dielectric nstant. L. PINCHERLE

538.566.2 : 621.317.41 : 621.317.335.3

10. The electric and magnetic constants of metallic ay media containing obstacles of arbitrary shape l thickness. S. B. COHN. *J. Appl. Phys.*, **22**, 628–34 *Tay*, 1951).

The dielectric constant and permeability of a tallic-obstacle medium are obtained by various tic methods. The equivalent shunt capacitive sceptance and series inductive reactance of the lividual obstacles are also determined. A corre- ondence is established between an infinitely thin nducting obstacle and an aperture in an infinitely n conducting wall; delay medium formulae are as given for several obstacle shapes. Formulae are en derived for the effect on the magnetic field of derate obstacle thickness. Finally, it is shown w the electric and magnetic constants may be luated by electrolytic tank measurements in the e of obstacles having completely arbitrary shape d thickness. This has been done for a typical delay dium, and the effect of obstacle thickness on the lex of refraction is shown. A.

538.566.2 : 621.396.812

11. Attenuation of radio signals caused by ttering. A. H. LAGRONE, W. H. BENSON, JR. AND W. STRAITON. *J. Appl. Phys.*, **22**, 672–4 (*May*, 51).

An equation is developed for determining the total wer scattered from an incident radio beam during passage through a unit scattering volume. Curves plotted from which the attenuation of the incident nal caused by scattering may be obtained. A.

538.566.3 : 621.396.11

5612. The effect of the Lorentz polarization term on the vertical incidence absorption in a deviating ionosphere layer. J. M. KELSO. *Proc. Inst. Radio Engrs*, **39**, 412–19 (*April*, 1951).

The effect is determined by using a double parabola approximation to the Chapman distribution of electron density as a function of height, and a single parabola approximation to the height distribution of the product of electron density $\times$ the collisional frequency. A constant $\times$ log (reflection coeff.) $\div$ (scale height) $\times$ (collisional frequency at max. ionization level) is obtained as a function of the ratio of the wave frequency to the vertical incidence critical frequency. This is compared with a similar result for the Sellmeyer theory of dispersion as given by Hacke [Abstr. 3393 (1948)]. The results for a type of "non-deviating region" absorption are compared for both theories. The expression for the apparent height of reflection using the Lorentz theory is derived and compared with that obtained by Hacke for the Sellmeyer theory. The latter results are given for use in the experimental determination of the scale height in the layer. The determination of the value of the collisional frequency at the level of maximum ionization is discussed for both theories. In all of this work the following assumptions are made: (1) the region is of Chapman form, with all the attendant restrictions; (2) the earth's magnetic field may be neglected; (3) the operating frequency is $\geqslant$ the collisional frequency wherever appreciable absorption occurs; and (4) the absorption per vacuum wavelength is small. It is concluded that, with sufficient sensitivity in the measurement of the reflection coefficient, it may be possible to use this material in deciding whether the Lorentz or Sellmeyer theory of dispersion should be used in ionospheric calculations. A.

538.569.3

5613. Influence of temperature upon ultra-Herztian absorption by water of crystallization and water of adsorption. (Liquid state of adsorbed water up to -90°C.) M. FREYMANN AND R. FREYMANN. *C.R. Acad. Sci. Paris*, **232**, 1096–8 (*March* 12, 1951) *In French.*

The variation of absorption ($\lambda = 3{\cdot}15$ cm) with temperature is investigated for ice-water, NaCl–H_2O, and water adsorbed on alumina and on silica. The curves obtained show abrupt discontinuities at the fusion and entectic points for water of crystallization, but continuity as far as -90°C for water of adsorption, thereby indicating continuity of the liquid state of the molecules well below 0°C. The anomalous position of water in the series H_2Te, H_2Se, H_2S, H_2O, due to the existence of hydrogen bonds, thus disappears for adsorbed water. Three curves are included. H. H. HODGSON

538.569.3

5614. Absorption by adsorbed water within the range of kilometric waves. M. T. ROLLAND AND R. BERNARD. *C.R. Acad. Sci., Paris*, **232**, 1098–9 (*March* 12, 1951) *In French.*

The absorption of waves of frequencies 1, 2, 5, 10 and 16 kc/s by water adsorbed on silica gel, when measured as a function of temperature (+ 40° to

— 150°c) and of the amount of adsorbed water, is shown to occur in two regions, viz., ~ 0°c for associated water, and ~ — 100°c for water dissociated by adsorption. H. H. HODGSON

538.569.3

5615. On the absorption of u.h.f. radio waves by opalescent binary liquid mixtures. A. CHOUDHURY. *Indian J. Phys.*, **24**, 507–12 (*Nov.*, 1950).

The absorption of u.h.f. radio waves in 2 opalescent mixtures have been investigated in the frequency range 300–510 Mc/s. It is concluded from the results that in the case of each of the 2 mixtures the polar molecules form 2 types of groups, in one of which the nature of packing of the molecules is identical with that in the pure liquid and in the other type the molecules are more closely packed. The non-polar molecules of the solvent do not seem to be able to penetrate into these groups of polar molecules. This method gives definite information regarding the change in the intermolecular field which takes place with the mixing up of polar molecules with non-polar molecules and furnishes definite information regarding the composition of the groups formed in opalescent mixtures. A.

538.569.3 : 621.317.335.3

5616. The dielectric constant and refractive index of air and its principal constituents at 24 000 Mc/s. L. ESSEN AND K. D. FROOME. *Nature, Lond.*, **167**, 512–13 (*March* 31, 1951).

The method is based on the difference between the resonant frequencies of a cavity when filled with the gas and when evacuated. The frequencies are measured directly in terms of a quartz standard with a precision of 1×10^{-8}, the cavity, which forms one arm of a waveguide bridge, being set to resonance by the micrometer adjustment of a coaxial plunger. The accuracy of the measurement is $\pm\,1\times10^{-7}$ and the value for dry air is in close agreement with the most recent optical determinations extrapolated to infinite wavelengths. A formula is given for obtaining the value for moist air at specified atmospheric conditions. A.

MAGNETIC EFFECTS 538.6

538.614

5617. The optical detection of electronic resonance by the observation of the paramagnetic rotation of the plane of polarization of visible light. A. KASTLER. *C.R. Acad. Sci., Paris*, **232**, 953–5 (*March* 5, 1951) *In French.*

It is argued that, since the Faraday effect depends on the relative populations of states defined by the magnetic quantum number m, and since a high-frequency field near resonance changes these populations, the Faraday effect can be used to detect paramagnetic resonance. The optimum conditions are discussed. J. R. MADDOX

538.614

5618. Investigation of the magnetic rotatory powers of the principal gases. R. DE MALLEMANN, F. SUHNER AND J. GRANGE. *C.R. Acad. Sci., Paris*, **232**, 1049–5[illegible] (*March* 12, 1951) *In French.*

The Verdet constants and magnetic rotatory power of H_2, O_2, N_2, air, CO_2 and A have been measured and are compared with previously recorded values. W. R. ANGU[illegible]

538.61[illegible]

5619. Magnetic rotatory powers of gaseous and liquid dimethyl ether. R. DE MALLEMANN, F. SUHNEI AND A. MALEVERGNE. *C.R. Acad. Sci., Paris*, **232**, 1385–7 (*April* 9, 1951) *In French.*

Details of exptl. procedure and the results obtained for $(CH_3)_2O$ in the liquid and gas phases are given. W. R. ANGU[illegible]

538.6[illegible]

5620. The change of the electrical resistance of bismuth crystals in strong magnetic fields. III. Experimental results. Y. TANABE. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 341–51 (*April*, 1950).

See Abstr. 4563 (1951) for previous part. The investigation reported previously was extended to the case of the current being inclined at various angles to the field and for different orientations of the crystal axis. Polycrystalline specimens were also studied. For $i\|H$ saturation effects were observed. E. P. WOHLFARTH

538.6[illegible]

5621. The Corbino effect and the change of resistance in a magnetic field. K. M. KOCH. Letter in *Phys. Rev.*, **82**, 460 (*May* 1, 1951).

Reports measurements of the relative change of resistance and the Hall coefficient at 80°K of a disk of Bi with a radial slit in it so as to decrease the flow of the circular component of current (Corbino current). Measurements were also made on mutilated plates. E. P. WOHLFARTH

538.63[illegible]

5622. On the Hall effect in ferromagnetics. N. ROSTOKER AND E. M. PUGH. Letter in *Phys. Rev.*, **82**, 125–6 (*April* 1, 1951).

An earlier discussion on the Hall effect in Ni [Abstr. 1955 (1951)] is amended by including the effect of the change of intrinsic magnetization with field at high fields. The previously noted Curie point anomaly in the temperature variation of the Hall coefficient R_0 is thereby removed. E. P. WOHLFARTH

538.65[illegible]

5623. Linear magnetostriction of homogeneous nickel alloys. J. J. WENT. *Physica*, **17**, 98–11[illegible] (*Feb.*, 1951).

The magnetostriction has been measured as a function of the composition of the alloy, of the induction caused by an external magnetic field and of the temperature. A comprehensive table of data is given. Several general relationships for binary alloys have been found. The saturation magnetostriction λ_s at 0°K can be predicted if the saturation induction I_s is known; λ_s at a higher temperature follows directly from the λ_s value at 0°K and the relation I_s *v T* (except for Ni–Mn alloys). A single relationship has been found between λ and I for alloys except those containing Co or Mn. From all these data the magnetostriction for ternary alloys may be calculated. A

538.652 : 548.0

5624. A phenomenological derivation of the first- and second-order magnetostriction and morphic effects for a nickel crystal. W. P. MASON. *Phys. Rev.*, **82,** 715–23 (*June* 1, 1951).

In order to account for experimental results which showed that the saturation elastic constants of a single Ni crystal varied with the direction of magnetization, a phenomenological investigation has been made of the stress, strain and magnetic relations for single Ni crystals. The variation in elastic constants is shown to be a "morphic" effect caused by the change in the crystal symmetry due to the magnetostriction effect. In the energy equation this effect is represented by additional terms which involve squares and products of both the magnetic intensities and stresses. These terms are as large as the magnetostrictive terms when the stresses are of the order of 10^{10} dynes/cm^2. The energy equation has been used to derive the 1st- and 2nd-order magnetostrictive effect, and the resulting terms agree with Becker and Doring's empirical constants for saturation conditions. For smaller magnetic intensities the terms divide up into 1st- and 2nd-order terms which vary differently with magnetic field intensity. It is shown that the morphic effects involve 6 measurable constants and some of these are evaluated experimentally. A.

538.653.1

5625. Internal friction of ferromagnetic materials. A. FERRO AND G. MONTALENTI. *J. Appl. Phys.*, **22,** 565–8 (*May*, 1951).

Aims at verifying experimentally the following hypothesis: in cyclically stressed ferromagnetic materials, energy loss because of magneto-elastic internal friction is induced by a domain motion due to the applied stress itself. The ratio I_r/I_s (where I_r = residual induction, and I_s = saturation intrinsic induction) has been chosen as an index of the domain position; its measure has been carried out by normal ballistic method on a permeameter rigged with a torsion applying device. Energy loss was measured by means of a torsion pendulum. Plotting curves of I_r/I_s and of magneto-elastic losses as a function of applied stress, it has been found that they show abrupt slope variations at practically the identical value of stress. It has further been observed that a specimen presenting only a low percent variation of I_r/I_s ratio showed also moderate magneto-elastic losses. The reason why motion of domains takes place in an essentially irreversible way still remains unknown. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

5626. Theory of the temperature effect of electronic energy bands in crystals. T. MUTO AND S. OYAMA. *Progr. Theor. Phys.*, **5,** 833–43 (*Sept.–Oct.*, 1950).

The temperature shift of energy bands in non-polar crystals is attributed to the interactions between electrons and lattice vibrations. The quantitative theory appears to be in agreement with results obtained by Pearson and Bardeen [Abstr. 6199 (1949)]. [Attention should also be drawn to a correction in Abstr. 4075 (1950)]. P. T. LANDSBERG

539.11

5627. On the configurational contribution to the heat capacity of binary solid solutions. V. HOVI. *Ann. Acad. Sci. Fennicae, Ser. AI, Paper* 88, 12 *pp.* (1951).

Some values have been calculated for the configurational contribution to the heat capacity of a 50 mole-% KCl–KBr mixed crystal at temperatures between 173·2 and 373·2°K. F. LACHMAN

539.11

5628. Calculations of surface energy for a free-electron metal. H. B. HUNTINGTON. *Phys. Rev.*, **81,** 1035–9 (*March* 15, 1951).

The surface energy is calculated using a square-cut barrier placed so that there is no net charge on the surface. The result is nearly independent of barrier height but leads to a value for surface tension less than half that observed for most molten metals. For Na a self-consistent surface barrier, first developed by Bardeen, is also used in numerical computation of surface energy. The value so obtained is about half that resulting from the use of the square-cut barrier. Previous theoretical treatments of this problem have generally predicted surface energies larger than observed. The opposite result in this case appears to result from the requirement that the surface be maintained electrically neutral. A.

539.11

5629. Correlation energy and the heat of sublimation of lithium. C. HERRING. Letter in *Phys. Rev.*, **82,** 282 (*April* 15, 1951).

It is shown that the discrepancy of about 4 kcal/mole between the theoretical and experimental values of the binding energy previously reported (Abstr. 2880 (1951)] is due primarily to the underestimation of the correlation energy term in the theory and the taking of too large a value of the experimental heat of sublimation. A. J. KENNEDY

539.11

5630. Erratum: On the cohesive energy of metallic lithium. R. A. SILVERMAN AND W. KOHN. Letter in *Phys. Rev.*, **82,** 283 (*April* 15, 1951).

See Abstr. 2880 (1951) and preceding Abstr. Correction of numerical error.

539.11

5631. Partition functions of cubic lattices. E. FISHER. *J. Chem. Phys.*, **19,** 632–40 (*May*, 1951).

The Born–von Kármán theory of vibrational specific heats is given an analytical development that is adequate for computation even at low temperatures. Application is made to simple, body-centred and face-centred cubic lattices. A.

539.11 : 530.162

A theory of cooperative phenomena. *See Abstr.* 5134

539.11 : 536.652

5632. Relation between atom vibrations of metals in solid state and their heats of fusion. L. JOLLIVET. *C.R. Acad. Sci., Paris*, **232**, 966–8 (*March* 5, 1951) *In French.*

When plotting the values of $H/Nh\nu$ (H = heat of fusion per gram-atom, N = Avogadro's constant, ν = limiting frequency of atom vibrations) against the principal quantum number of the external atomic level, two straight lines have been obtained for 17 metals: one for the face-centred cubic and the hexagonal close packing configuration, the other for the body-centred cubic configuration. The lines are straight in the interval $n = 1$ to 5; their equation is $H = \alpha(n - 1)Nh\nu$, where $\alpha = 1{\cdot}63$ for the first line, and $0{\cdot}90$ for the second line. F. LACHMAN

539.11 : 548.7

5633. On the theory of the heat of formation of solid solutions. J. A. WASASTJERNA. *Comment. Phys. Math., Helsingfors*, **15**, *Paper* 3, 13 *pp.* (1951).

The heat of formation of a gram-molecule of a mixed crystal KCl–KBr is calculated under 3 different assumptions: (1) all ions occupy their corresponding singular positions in a cubic face-centred lattice; (2) the lattice is assumed to be completely disordered; (3) the geometrical displacements are taken into account and the lattice is assumed to be characterized by a certain degree of local order. The assumptions under (3) lead to a very satisfactory agreement between theory and experiment.

F. LACHMAN

539.11 : 548.7

5634. On Wasastjerna's theory of the heat of formation of solid solutions. V. HOVI. *Comment. Phys. Math., Helsingfors*, **15**, *Paper* 12, 14 *pp.* (1951).

Formulae for the heat of formation in the case of binary mixed crystals of alkali halides have been deduced on the basis of Wasastjerna's theory (preceding Abstr.). The heat of formation corresponding to 20°C has been recalculated as a function of crystal composition for the combination KCl–KBr. Also the heat of formation (at 25°C) has been similarly calculated for the system KCl–RbCl. A good agreement between theory and experiment has been found in either case. F. LACHMAN

539.11 : 548.7

5635. On the configurational free energy of binary solid solutions of alkali halides. V. HOVI. *Comment. Phys. Math., Helsingfors*, **15**, *Paper* 15, 8 *pp.* (1951).

A new expression, $F(T, \sigma)$, has been deduced for the configurational free energy in the case of binary solid solutions of alkali halides in which only local order appears. It has been suggested that an expression obtained for the energy ΔQ could be used in the numerical evaluation of the energy emitted from a mixed crystal during its ageing. F. LACHMAN

539.11 : 548.7

5636. The configurational free energy of KCl–KBr mixed crystals at different temperatures. V. HOVI. *Comment. Phys. Math., Helsingfors*, **15**, *Paper* 16, 12 *pp.* (1951).

Numerical calculations have been carried out of the configurational free energy for the combination KCl–KBr. The curves corresponding to the configurational free energy as a function of crystal composition at several temperatures between $173{\cdot}2$ and $273{\cdot}2$°K show that the critical temperature below which the KCl–KBr system does not seem to form a gapless range of mixed crystals ought to be lower than — 100°C, which is in agreement with available experimental data. F. LACHMAN

539.11 : 548.7

5637. Entropy as function of local order for binary solid solutions of alkali halides. V. HOVI. *Comment. Phys. Math., Helsingfors*, **15**, *Paper* 17, 5 *pp.* (1951).

An expression has been deduced for the entropy change which takes place when a binary alkali–halide mixed crystal in which only local order appears passes from one state of order to another. Also numerical calculations have been carried out for a 50 mole-% KCl–KBr mixed crystal for the transition from — 100° to 0°C. F. LACHMAN

MOLECULAR STRUCTURE 539.13

539.132

5638. A quantum-mechanical one-dimensional model for special linear finite molecular chains (as possible model for forces between gene molecules in protoplasm). E. HÜCKEL AND W. BINGEL. *Ann. Phys. Lpz.*, **8** (*No.* 5–8) 391–404 (1951) *In German.*

The passage of electrons from one gene to another is correlated with the transmissivity of the box potentials assumed for the protoplasm molecules. The effects between the end molecules (genes) of a linear chain (protoplasm) are: equal end potential wells mean repulsion, but attraction in special cases; different ends mean repulsion, though weak attractions are possible for small end differences. J. JACOBS

539.132

5639. Electronic levels in simple conjugated systems. II. Butadiene. C. A. COULSON AND J. JACOBS. *Proc. Roy. Soc. A*, **206**, 287–96 (*May* 7, 1951).

The method of molecular orbitals, with configuration interaction, as described in I [Abstr. 8149 (1950)], is applied to butadiene. The total energy, ultraviolet absorption frequency, oscillator strength and charge distribution are calculated for several singlet and triplet states in general agreement with similar more empirical work using the valence-bond approximation. It appears that without configuration interaction, no satisfactory calculation of the absolute intensities of the $N \rightarrow V$ transitions can be made. Best-possible molecular orbitals, compounded linearly of $2p\pi$ atomic orbitals, are obtained. Their use reduces the magnitude of configuration interaction from $2{\cdot}8$ to $1{\cdot}7$ eV in the ground state. It also gives a satisfactory measure of the energy of the first allowed transition, but not of the oscillator strength. A.

539.132

5640. Electronic levels in simple conjugated systems. III. The significance of configuration interaction.

C. A. Coulson, D. P. Craig and J. Jacobs. *Proc. Roy. Soc. A*, **206**, 297–308 (*May* 7, 1951).

The features of configuration interaction calculations in π-electron systems so far reported are analysed and compared with some atomic, and diatomic molecular, systems. The interactions between configuration wave functions are not negligible in atoms and are important in molecules bound either by σ- or π-electrons. In the one case where comparison is possible, viz. in H_2, the magnitude of the effect is reduced to one-half when the configurations refer to self-consistent field orbitals rather than to linear combinations of atomic orbitals. The situation in which a consideration of configuration interaction is inescapable is for the configurations of a shell of molecular electrons where, typically, the spread of the energies is small compared with the total electronic energy. In cyclobutadiene, butadiene, benzene and naphthalene, i.e. in all cases so far reported, even the order of some of the states is changed. The wave functions derived in these calculations are markedly better than single-configuration ones, as judged by the much better agreement between calculated and experimental spectral transition probabilities. A.

539.132

5641. Some considerations on the strengths of hybrid bonds in excited states of the hydrogen molecule-ion. H. O. Pritchard and H. A. Skinner. *J. Chem. Soc.* (1951) 945–52 (*April*).

The potential-energy curves for a series of defined states of H_2^+ are calculated by the molecular-orbital method. The results are compared with those of a similar study by Pauling and Sherman, from which the present work differs in that the correct H atom eigenfunctions are used in place of the approximate Slater eigenfunctions. The calculated ratio of 1 : 3 : 4 obtained by Pauling and Sherman for the relative strengths of *s–s*, *p–p* and sp^3–sp^3 bonds in the 2- and 3-quantum states of H_2^+ is not found. Calculations on the ground state of H^+ show that the description of this state as a 1*s*–2*p* hybrid ($Z = 1$) gives a very close approximation in respect of the energy, but the calculated bond length is too small, and the calculated force constant too large. The additional variation in Z (Dickinson) corrects the error in r_e. An examination of Badger's rule ($k_e^{-\frac{1}{3}} \propto r_e$) applied to the calculated constants for the different states of H_2^+ shows that the rule is followed rather closely when states of similar bonding are considered as a class. A.

539.132 : 541.64

5642. Electric moments of polar polymers in relation to their structure. P. Debye and F. Bueche. *J. Chem. Phys.*, **19**, 589–94 (*May*, 1951).

In general, the polymer coil diameter found by light scattering methods is much larger than that calculated from a model with free rotation. This increase in size can satisfactorily be attributed to hindering of rotation around the chemical bonds. To obtain information about structural details of this hindered rotation, however, the size determination will have to be combined with evidence derived from other sources, e.g. the dipole moment, as derived from measurements of the dielectric constant of polymer solutions. If a number of units are connected to each other in a chain, the contribution of the whole chain may be larger or smaller than would be the case if the units were free, depending on whether positions of parallelism or antiparallelism of the elementary electric moments are preponderant, taking the average over all the possible forms the coiling molecule can assume. A theory has been worked out, and experiments carried out. A.

539.133

5643. Integral equations between distribution functions of molecules. S. Ono. *Progr. Theor. Phys.*, **5**, 822–32 (*Sept.–Oct.*, 1950).

Mayer's general variational method is correlated with the integral equations of Kirkwood and of Born and Green. For the latter a generalization to multicomponent systems is possible; and also to the case when both fugacity sets with two related sets of pair distribution functions are non-zero. J. JACOBS

539.133

5644. Dipole moment and electric quadrupole effects in HNCO and HNCS. J. N. Shoolery, R. G. Shulman and D. M. Yost. Letter in *J. Chem. Phys.*, **19**, 250–1 (*Feb.*, 1951).

A comparison of the quadrupole coupling constants in some cyanides and isocyanates favours the structures HNCO and HNCS. J. JACOBS

539.133

5645. Calculation of the molecular diameters from Sutherland's constant. M. el Nadi. Letter in *J. Chem. Phys.*, **19**, 503–4 (*April*, 1951).

London's molecular forces arising from polarizabilities are consistent with Sutherland's molecular model. J. JACOBS

539.133

5646. Lewis acids and bases and molecular complexes R. S. Mulliken. Letter in *J. Chem. Phys.*, **19**, 514–15 (*April*, 1951).

Intermolecular charge-transfer forces have strong directional properties. Charge-transfer spectra are intense even for loose complexes. J. JACOBS

539.133

5647. Out-of-plane hydrogen vibrations in triborine triamine. R. A. Spurr and S.-C. Chang. Letter in *J. Chem. Phys.*, **19**, 518 (*April*, 1951).

Bell's potential function leads to satisfactory agreement with observed frequencies. Interactions between H-bonds at meta positions seem unnecessary. J. JACOBS

539.133

5648. Molecular orbital calculations for H_3. J. M. Walsh and F. A. Matsen. *J. Chem. Phys.*, **19**, 526–8 (*May*, 1951).

Calculations are made on the binding energy of H_3 using the several methods of calculation based on molecular orbitals. The results are compared to the valence bond-plus-ionic-terms treatment of Hirschfelder *et al.* which employs the most general linear combination of products of atomic orbitals. The antisymmetrized molecular orbital treatment with configuration interaction is only slightly inferior to this treatment, while the other molecular orbital

calculations are considerably inferior. These conclusions probably apply to calculations on more complex molecules. A.

539.133 : 535.343.2

Infra-red spectra and structure of fibrous proteins. *See Abstr.* 5271

539.133 : 535.343.4–14

5649. Some molecular dipole moments determined by microwave spectroscopy. J. N. SHOOLERY AND A. H. SHARBAUGH. Letter in *Phys. Rev.*, **82,** 95 (*April* 1, 1951).

Values observed with a Stark effect waveguide cell of known electrode spacing:—OCS 0·712 ± 0·0004, HNCO 1·592 ± 0·010, H_2CO 2·339 ± 0·013, CHF_3 1·645 ± 0·009 D. D. H. WHIFFEN

539.133 : 541.5

5650. The general valence orbitals derivable by sp_3 hybridization. P. TORKINGTON. *J. Chem. Phys.*, **19,** 528–33 (*May*, 1951).

An examination is made of the allowed sets of four sp_3-hybrid orbitals satisfying the symmetry requirements of the point groups C_{2v} and C_{3v}, the object of the analysis being to aid in the formalization of the study of deviations from the ideal tetrahedral valence angle, found in systems of symmetry lower than T_d. Tables of allowed interorbital angles are given. A.

539.133 : 541.57

5651. Tripyramidal bond orbitals. G. H. DUFFEY. *J. Chem. Phys.*, **19,** 553–4 (*May*, 1951).

Three 9-bond arrangements which are not forbidden in *spd* hybridization are described. Of these, the tripyramidal arrangement is discussed in detail since it seems most favourable stericly. In this arrangement there are 2 types of orbitals, 6 trigonal prism orbitals and 3 equatorial orbitals. When the average orbital strength is greatest, it equals 2·983. Some light is thrown on the following structures: TaF_7^{-2}, OsF_8, and conjectural OsF_9^-. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152

5652. Solutions of the Fermi–Thomas–Dirac equation. N. METROPOLIS AND J. R. REITZ. *J. Chem. Phys.*, **19,** 555–73 (*May*, 1951).

Solutions of the Fermi–Thomas–Dirac equation are given for 24 different elements. Both neutral atom and positive ion solutions are given. These results were obtained by evaluating the series expansion for the FTD function at small distances from the origin and by numerical integration of the differential equation at larger distances. The numerical solutions were done on the ENIAC. A.

539.152.1

5653. Model experiments on the drop model of the atomic nucleus. E. SAAR. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 253–69 (1951) *In German.*

The theory of the capillary oscillations of a charged irrotational-liquid drop is given, including damping by viscosity. General agreement is found with experimental frequencies (investigated by means of soap bubbles and water drops) of the few lowest modes and with the dependence on the charge of the energy of excitation necessary to produce fission. W. J. SWIATECKI

539.152.1

5654. Nuclear models. V. WEISSKOPF. *Science*, **113,** 101–2 (*Jan.* 26, 1951).

The "independent particle" and "strong interaction" models of the nucleus are described. An explanation of the apparent paradox concerning the different strengths of the nuclear interactions implied by them is suggested to be due to the exclusion principle which for low energy processes and ground state characteristics decreases the effectiveness of the interactions (by analogy with electron theory of metals). W. J. SWIATECKI

539.152.1

5655. The spin of Be^9. N. A. SCHUSTER AND G. E. PAKE. Letter in *Phys. Rev.*, **81,** 886–7 (*March* 1, 1951).

Direct experimental evidence that the spin of Be^9 is 3/2 has been obtained from the Be^9 magnetic resonance in a single crystal of $BeAl_2O_4$. L. PINCHERLE

539.152.1

5656. Mirror levels in Li^7 and Be^7. B. R. MOTTELSON. Letter in *Phys. Rev.*, **82,** 287 (*April* 15, 1951).

The difference of the energies of the 1st excited levels of these two can be attributed to the different e.m. properties of the neutron and proton. Correct lifetimes for these states are predicted. G. J. KYNCH

539.152.1

5657. Energy level perturbation of a particle in a spheroidal potential well. S. GALLONE AND C. SALVETTI. Letter in *Phys. Rev.*, **82,** 551 (*May* 15, 1951).

539.152.1

5658. Low states of Li^7 in intermediate coupling. H. H. HUMMEL AND D. R. INGLIS. *Phys. Rev.*, **81,** 910–14 (*March* 15, 1951).

The intermediate-coupling transition of the five lowest levels of Li^7–Be^7 is discussed. Some analytical emphasis is placed on the approach from the (*jj*) coupling extreme with ordinary (non-exchange) interactions, in which case there is a first-order degeneracy which might have helped explain the scarcity of low levels, but second-order perturbations are shown to be too large. The only possibility of obtaining just two isolated low levels with either ordinary or Majorana interactions lies near the (*LS*) coupling extreme, with angular momentum $I = 1/2$ for the excited state. A.

539.152.1 : 537.533.74

5659. Effect of finite nuclear size on the elastic scattering of electrons. L. K. ACHESON, JR. *Phys. Rev.*, **82,** 488–94 (*May* 15, 1951).

The effect of electrons with energies in the neighbourhood of 20 MeV has been calculated for 2 simple spherical nuclear models: a uniform charge distribution, and a uniform shell charge distribution, both of radius $R = 1{\cdot}45 \times 10^{-13} A^{\frac{1}{3}}$ cm. An exact phase shift analysis has been made, the phase shifts differing appreciably from those for a point nucleus only in the

$j = \frac{1}{2}$ state. Phase shifts for elements of $Z = 13$, 29, 50 and 79 have been plotted as a function of energy over the interval from 15 to 35 MeV, permitting the calculation of any desired cross-section within this range. Representative curves of the ratio of the scattering cross-section for the finite nucleus to that for a point nucleus have been plotted. The difference in the scattering due to the 2 models is large enough for accurate experiments to distinguish between them, the actual average nuclear charge distribution probably falling somewhere between these 2 cases. The ability to differentiate between the 2 models, however, depends on the accuracy with which nuclear radii are known. A.

539.152.2

5660. The $B^{10}(n, \alpha)$ reaction and the low excited state of Li^7. D. R. INGLIS. *Phys. Rev.*, **81**, 914–19 (*March* 15, 1951).

Conflicting evidence concerning the nuclear spin I of the low excited state of Li^7 is discussed. By comparison of the apparent likelihood of sufficiently unexpected behaviour of the matrix elements involved in the interpretation of the various experiments, it is concluded that the original assignment $I = \frac{1}{2}$ is almost certainly correct. The only evidence against $I = \frac{1}{2}$ is the strong preference of the thermal-neutron reaction $B^{10}(n, \alpha)Li^7$ for the transition to the excited state. This anomalous intensity ratio is about what would be expected with $I = 5/2$; but with $I = \frac{1}{2}$, even the most favourable assumptions leave a factor of over thirty in the intensity ratio, or about six in the matrix elements, to be ascribed to unexpected behaviour of the incalculable nuclear factors. The strongest evidence for $I = \frac{1}{2}$ is found in the observed approximate lack of alpha-gamma angular correlation in the same reaction. Another experimental result which seems natural with $I = \frac{1}{2}$, the isotropy of the gammas accompanying inelastic scattering of protons from Li^7, could be ascribed to chance properties of the compound nucleus; but it is unlikely that both of these results, each of which favours $I = \frac{1}{2}$, should occur fortuitously. A.

539.152.2

5661. The nuclear spins and quadrupole moments of stable germanium isotopes. J. M. MAYS AND C. H. TOWNES. *Phys. Rev.*, **81**, 940–1 (*March* 15, 1951).

Analysis of the hyperfine structure of spectral lines arising from the $J = 0 \rightarrow 1$ rotational transition of GeH_3Cl allows the assignment of zero spin to the nuclei of Ge^{70}, Ge^{72}, Ge^{74}, and Ge^{76}, and a spin of 9/2 to Ge^{73}. The nuclear quadrupole moment of Ge^{73} is determined to be $(-0{\cdot}2 \pm 0{\cdot}1) \times 10^{-24}$ cm^2. A.

539.152.2

5662. A direct determination of the magnetic moment of the protons in units of the nuclear magneton. C. D. JEFFRIES. *Phys. Rev.*, **81**, 1040–55 (*March* 15, 1951).

A direct measurement of the proton magnetic moment in units of the nuclear magneton has been made, using the method of Alvarez and Bloch. The experiment consists of comparison of the nuclear magnetic resonance frequency of protons with the orbital frequency of protons revolving in the same homogeneous field. The resonance frequency of protons in water has been measured by the method of nuclear induction; the orbital frequency has been measured by a special device: a small decelerating cyclotron operated at an odd multiple of the fundamental cyclotron frequency. The device has been operated in a field of about 5 300 gauss at all odd multiples from the first to the eleventh, with a corresponding range of the dee frequency between 8·1 and 89 Mc/s. As expected, the sharpness of the cyclotron resonance was observed to increase greatly at the higher multiples. An approximate theory for the shape of the cyclotron resonance curves has been developed, and its qualitative agreement with the observations has been established. The perturbing effects of extraneous electric and magnetic fields have been investigated, both theoretically and experimentally, and found to be negligible. With the smallest relative half-width of resonance about 1/10 000, which was observed at the higher multiples, and guided by the interpretation of the resonance shape, the magnetic moment of the proton has been found to be $2{\cdot}7924 \pm 0{\cdot}0002$ nuclear magnetons. A.

539.152.2

5663. Chemical effects on nuclear induction signals from organic compounds. J. T. ARNOLD, S. S. DHARMATTI AND M. E. PACKARD. Letter in *J. Chem. Phys.*, **19**, 507 (*April*, 1951).

The influence of magnetic shielding on the magnetic resonance frequency of a nucleus is discussed. Results are tabulated for the first 5 primary aliphatic alcohols using a nuclear induction apparatus of high resolving power. W. R. ANGUS

539.152.2

5664. The nuclear magnetic moment of I^{129}. H. WALCHLI, R. LIVINGSTON AND G. HERBERT. Letter in *Phys. Rev.*, **82**, 97 (*April* 1, 1951).

Measurements were made in a Bloch-type nuclear induction apparatus [Abstr. 8167 (1950)] by comparison with D. $\mu(I^{129}) = +2{\cdot}6173 \pm 0{\cdot}0003$; $\mu(I^{127}) + 2{\cdot}8090 \pm 0{\cdot}0004$; $127/129 = 1{\cdot}0732$

539.152.2

5665. On the spin of the nuclear ground state in the *jj*-coupling scheme. I. TALMI. Letter in *Phys. Rev.*, **82**, 101–2 (*April* 1, 1951).

Calculations of the spin of the ground state of the j^n configuration, under the assumption of purely Maiorana forces, indicate that the Mayer approximation for the potential between a pair of nucleons is more reasonable than the "long range" one for physically interesting cases. L. PINCHERLE

539.152.2

5666. On the magnetic moment of Mg^{25}, Re^{185}, Re^{187}, and Be^9. F. ALDER AND F. C. YU. Letter in *Phys. Rev.*, **82**, 105 (*April* 1, 1951).

539.152.2

5667. Nuclear magnetic moments and similarity between neutron and proton states in the nucleus. A. L. SCHAWLOW AND C. H. TOWNES. Letter in *Phys. Rev.*, **82**, 268 (*April* 15, 1951).

The deviations from the Schmidt lines of the magnetic moments of pairs of nuclei with the same odd number of protons or neutrons are very similar. On this principle a fairly accurate prediction of some yet unknown magnetic moments is possible. L. PINCHERLE

539.152.2

5668. The quadrupole moment ratio of Cl^{35} and Cl^{37} from pure quadrupole spectra. R. LIVINGSTON. Letter in *Phys. Rev.*, **82**, 289 (*April* 15, 1951).

From the spectra of five compounds the average value for the ratio was found to be $1{\cdot}26878 \pm 0{\cdot}00015$. Nuclear polarization by the external electric field was absent in these measurements. L. PINCHERLE

539.152.2 : 538.113

5669. On the spin and magnetic moment of O^{17}. F. ALDER AND F. C. YU. Letter in *Phys. Rev.*, **81**, 1067–8 (*March* 15, 1951).

Nuclear induction signals lead to $\mu = -1{\cdot}8928 \pm 0{\cdot}00019$ nm, spin 5/2 for O^{17}. D. H. WHIFFEN

539.152.2 : 538.221 : 537.311.1

5670. Interaction between the *d*-shells in the transition metals. II. Ferromagnetic compounds of manganese with perovskite structure. C. ZENER. *Phys. Rev.*, **82**, 403–5 (*May* 1, 1951).

Abstr. 4616 (1951) part I. Recently, Jonker and Van Santen have found an empirical correlation between electrical conduction and ferromagnetism in certain compounds of Mn with perovskite structure. This observed correlation is interpreted in terms of those principles governing the interaction of the *d*-shells of the transition metals which were enunciated in part I. Both electrical conduction and ferromagnetic coupling in these compounds are found to arise from a double exchange process, and a quantitative relation is developed between electrical conductivity and the ferromagnetic Curie temperature. A.

539.152.2 : 538.222

5671. On the spacial alignment of nuclei. B. BLEANEY. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 315–16 (*March*, 1951).

It is pointed out that alignment of the type envisaged by Pound can in certain cases be obtained by demagnetizing a paramagnetic salt with h.f.s. due to magnetic interaction. L. PINCHERLE

539.152.2 : 539.181

5672. The deuteron quadrupole moment and the radiofrequency spectra of H_2 and D_2 in low magnetic fields. H. G. KOLSKY, T. E. PHIPPS, JR., N. F. RAMSEY AND H. B. SILSBEE. Letter in *Phys. Rev.*, **81**, 1061 (*March* 15, 1951).

Preliminary measurements of the r.f. spectra below 10 gauss with a molecular beam give $Q = (2{\cdot}738 \pm 0{\cdot}016)\ 10^{-27}$ cm^2 for the D nucleus. D. H. WHIFFEN

539.153 : 530.145.6 : 517.6

Electronic wave functions. *See Abstr.* 4996

539.153 : 535.338

5673. Spin–spin interaction. R. E. TREES. *Phys. Rev.*, **82**, 683–8 (*June* 1, 1951).

Araki has suggested that spin-spin and spin-other-orbit interactions have an appreciable effect on the intervals of multiplets in spectra of heavy elements. He has shown that for a large number of elements the three intervals of a quartet (or the four of a quintet, etc.) can be calculated from a relation involving two arbitrary constants. The matrix elements of spin-spin interaction for d^n configurations have been calculated so that comparison can be made between different multiplets. The results are applied to 8 multiplets of Fe III, taking account of non-diagonal spin-orbit elements with 2nd-order perturbation theory. The agreement obtained seems to warrant the conclusion that spin-spin effects are appreciable. An analysis of the electrostatic interaction in the d^6 configuration of Fe III has also been made. A.

539.153 : 539.165

5674. Orbital perturbation effects in beta-decay. H. M. SCHWARTZ AND R. R. EDWARDS. Letter in *J. Chem. Phys.*, **19**, 385–6 (*March*, 1951).

The excess atomic binding energy liberated in negative β-decay may provide the energy for atomic excitation and ionization. J. JACOBS

539.155

5675. Some new atomic mass measurements and remarks on the mass evidence for magic numbers. H. E. DUCKWORTH AND R. S. PRESTON. *Phys. Rev.*, **82**, 468–70 (*May* 15, 1951).

New mass measurements are given for the nuclei Ti^{48}, Sr^{86}, Sr^{88}, Mo^{98}, Sn^{117}, Sn^{120}, Pt^{194}, Pt^{196} and Pb^{208}. The evidence given for the theory of magic numbers in nuclear structure by nuclear mass measurements is discussed. A.

539.155.1

5676. A property of the mass-ratio $m_{Cl^{35}}/m_{O^{16}}$. P. TORKINGTON. Letter in *J. Chem. Phys.*, **19**, 659 (*May*, 1951).

If $\mu = m_{Cl^{35}}/m_{O^{16}}$, then $\mu(1 + 2\mu) = 11{\cdot}746_4$ and $1 + 2(1 + 2\mu) = 11{\cdot}745_4$. If the two functions are equated, then the mass-ratio arises as the (positive) root of the equation $(1 + 2\mu)(\mu - 2) = 1$, or $2\mu^2 - 3(\mu + 1) = 0$.

539.155.1 : 535.343.4–14

5677. The mass of S^{35} from microwave spectroscopy. T. WENTINK, JR., W. S. KOSKI AND V. W. COHEN. *Phys. Rev.*, **81**, 948–51 (*March* 15, 1951).

The $J = 1 \rightarrow 2$ rotational absorption transition in OCS has been observed for the molecules containing S^{35} and S^{34}. From the frequencies, the frequency differences, and the previously known frequencies of S^{34}, S^{33} and S^{32} the mass difference ratios $(S^{35} - S^{32})/(S^{34} - S^{32})$ and $(S^{35} - S^{32})/(S^{33} - S^{32})$ have been evaluated. From these values and values of the stable S masses two independent values of the $(S^{35} - S^{32})$ mass differences are calculated to be $2{\cdot}99844 \pm 0{\cdot}00042$ and $2{\cdot}99770 \pm 0{\cdot}00048$, respectively. A.

539.155.2

5678. On gas-centrifuges. Enrichment of the Xe, Kr, Se-isotopes by the centrifuge method. K. BEYERLE, W. GROTH, P. HARTECK AND H. JENSEN. *Beih. angew Chem. u. Chem.-Ingen.-Tech., No.* 59, 67 *pp.* (1950) *In German.*

Description of gas centrifuges developed in Germany during and since the war. Apart from plain hollow cylinders, there are modifications in which the inside is subdivided in the axial direction into several chambers in such a manner that the axial part of one chamber communicates with the peripheral part of the next chamber. Mixing between the regions thus connected is obtained by periodic variation of

the gas pressure in a reservoir connected to one end of the centrifuge. In this way it was hoped to enhance the single stage separation, but difficulties were encountered in transmitting the pressure changes through the centrifuge. Parasitic convections due to spurious temperature differences are discussed. They were eventually overcome by adding H_2 to the isotope mixture. Various aspects of mechanical stability and of the theory of isotope separation are considered. Experiments were carried out with Kr, Xe, UF_6 and SeH_2. Substantial changes in isotopic composition were obtained, though usually somewhat lower than theoretically expected except in the case of the hydrogen-stabilized simple centrifuge. Here in experiments with SeH_2 the theoretical separation was even exceeded. This was attributed to favourable convections initiated by adiabatic cooling at one end of the centrifuge during sampling. See Abstr. 5680 (1951). H. LONDON

539.155.2

5679. Convection processes in the gas centrifuge. Thermoconvection in a strong gravitational field. H. MARTIN. *Z. Elektrochem. angew. Phys. Chem.*, **54**, 120–29 (*March*, 1950) *In German.*

The velocity of a gas rising between two vertical parallel plates kept at a temperature $>$ the temperature T_0 of the surrounding gas is calculated. If the distance of the plates is large, the adiabatic cooling of the rising gas prevents the heat supplied by the walls from reaching the central regions. Consequently the gas rises only in the regions adjoining the walls. At the far end of these regions the gas temperature is actually a little less than T_0. This causes a slight downward movement in an adjoining region, until finally the velocity becomes asymptotically zero and the temperature T_0. The velocity maximum is at a distance $d = \frac{1}{2}\pi(\eta\lambda T_0)^{\frac{1}{4}}(2g\rho_0)^{-\frac{1}{2}}$. Here η = viscosity, λ = thermal conductivity, ρ_0 = density and g = acceleration of gravity. d is less than 1 mm in the gravitational fields found in a gas centrifuge ($g \sim 10^8$). Expressions are given for the velocity and temperature distribution in the general case where the wall distance is comparable with d. The cases in which g varies in the direction of the flow, in which the two walls are at the temperatures $T_0 + \Delta T$ and $T_0 - \Delta T$, and in which there is a forced convection are discussed and the limits of the applicability of the theory are given. The results are applied to problems arising in gas centrifuges, but the effect of the Coriolis forces is not taken into account.

H. LONDON

539.155.2

5680. Isotope enrichment in ultracentrifuges with hydrogen stabilization. W. GROTH AND P. HARTECK. *Z. Elektrochem. angew. Phys. Chem.*, **54**, 129–31 (*March*, 1950) *In German.*

The advantages of adding H_2 to the isotope mixture [Abstr. 5678 (1951)] are discussed in greater detail. The more than single stage enrichment obtained with SeH_2 is explained by the self-fractionating effect of a flow pattern similar to that occurring in a Clusius–Dickels thermal diffusion tube. Here it is produced by the adiabatic cooling of the gas at the withdrawal end. This, together with the centrifugal force, causes an axial pressure gradient which varies with the distance from the axis and gives rise to a flow towards the sampling end in the axial region and away from it in the peripheral region. H. LONDON

539.155.2

5681. Increase in the enrichment of gaseous isotopes in ultracentrifuges. V. FALTINGS, W. GROTH and P. HARTECK. *Naturwissenschaften*, **37** (*No.* 21) 490–1 (1950) *In German.*

A 1·5-fold increase of the simple process separation was obtained with Xe in a H_2-stabilized centrifuge when the temperature of one end was increased by an electrical heater (see preceding abstr.). Attempts to obtain an increase by means of a stationary electrically heated axial wire were unsuccessful. No separation was obtained, whether the wire was heated or not. This was attributed to vibrations of the wire causing turbulent mixing. H. LONDON

539.155.2 : 541.135

5682. An apparatus for the production of pure deuterium from heavy water. M. M. WINN. *J. Sci. Instrum.*, **28**, 152 (*May*, 1951).

Electrolysis is used to produce the gas in a small, easily constructed apparatus. Purification is carried out by diffusion through a Pa tube. The plant uses about 10 g of electrolyte and may be left unattended during operation. A.

539.155.2 : 551.510.4

5683. Does diffusive separation exist in the atmosphere below 55 kilometers? D. W. HAGELBARGER, L. T. LOH, H. W. NEILL, M. H. NICHOLS AND E. A. WENZEL. Letter in *Phys. Rev.*, **82**, 107–8 (*April* 1, 1951). See Abstr. 1259 (1951).

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

5684. Radiation measuring instruments for X-rays to cosmic rays. D. TAYLOR AND W. ABSON. *Instn. Elect. Engrs. Paper* 1148, 11 *pp* [*Early Proof Issue*].

The radiations and particles are classified as: X-rays and γ-rays, charged particles, and uncharged particles; in each case an account is given of the more important measurable quantities (e.g. energy, W, flux of radiation, Φ, radiation dosage, r, etc.) and the physical basis of the method. The examples chosen are process instruments developed at the Atomic Energy Research Establishment to provide continuous monitoring of α- and β-activities in solution. In the α-activity instrument the pulse technique is used for individual particles, whereas in the β-activity instrument the mean rate of ionization is measured as a direct current. In nucleonic-instrument design the following aspects are discussed: source-detector geometry, detectors in assay instruments, special problems associated with portable instruments and materials and finishes for radioactive-contamination monitoring instruments. A.

539.16.08

5685. Archaeological dating by radioactive carbon. F. E. ZEUNER. *Sci. Progr.*, **39**, 225–38 (*April*, 1951).

Reviews theory, history, technique, results and degree of accuracy. 13 refs.

539.16.08 : 621.317.39 : 621.389

5686. A radon measuring device. E. K. DARBY AND H. E. JOHNS. *Amer. J. Roentgenol. Radium Ther.*, **65**, 472–5 (*March*, 1951).

A d.c. amplifier with negative feedback, connected to an ionization chamber, gives a direct reading of strength of radon seeds, with full-scale deflection for 1·5 mC. Commercial valves are used, and the circuit has high stability and freedom from zero drift even when operated from unregulated mains supplies.

F. T. FARMER

539.163

5687. Heat production in potassium. D. E. ALBURGER. Letter in *Phys. Rev.*, **81**, 888 (*March* 1, 1951).

From the most recent decay data, this is calculated to be $27 \pm 1\ 10^{-6}$ cal/gmk/year [see Abstr. 4284 (1949)]. B. ROSE

539.163

5688. Long-lived Bi^{207} and energy levels of Pb^{207}. H. M. NEUMANN AND I. PERLMAN. *Phys. Rev.*, **81**, 958–62 (*March* 15, 1951).

Long-lived Bi^{207} has been prepared by deuteron irradiation of Pb and from the alpha-decay of At^{211}. From the genetic relationship with At^{211}, the half-life is estimated as 50 years. The conversion electron spectrum has been determined and is discussed in terms of the energy states of Pb^{207}. Further evidence on these states has been obtained from the discovery of three rare alpha-groups in the decay of Po^{211} of energies 6·90, 6·57 and 6·34 MeV, which are compared with the main group at 7·43 MeV. A.

539.163

5689. Radiations from Yb^{169}. D. S. MARTIN, JR., E. N. JENSEN, F. J. HUGHES AND R. T. NICHOLS. *Phys. Rev.*, **82**, 579–88 (*June* 1, 1951).

The radiations from Yb^{169} have been examined by means of a thin lens spectrometer and absorption-coincidence techniques. The half-life was found to be $33 \pm 1·5$ days. The half-life of the metastable state was determined as 0·67 μ sec. Yb^{169} decays by electron-capture to Tm^{169}. Eleven gamma-rays were observed in the photoelectron and internal conversion spectra determined with the spectrometer. On the basis of the absorption-coincidence and spectrometer data, two decay schemes are discussed. A.

539.163 : 530.132

5690. Notes on fluctuation in nuclear evaporation process. K. TAKAYANAGI AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **5**, 894–6 (*Sept.–Oct.*, 1950).

Fluctuations in the number of particles emitted are found to obey Poisson's law. W. J. SWIATECKI

539.163.1

5691. Radioactive ^{159}Dy. F. D. S. BUTEMENT. Letter in *Proc. Phys. Soc. Lond. A*, **64**, 428 (*April*, 1951).

See Abstr. 6033 (1950). The $\frac{1}{2}$-life was measured as 132–136 days, and only Tb *K* and *L* X-rays were emitted.

539.163.1

5692. The half-life of carbon 14. G. G. MANOV AND L. F. CURTISS. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 328–33 (*April*, 1951).

This has been determined by gas counting of $C^*O_2 + CS_2$ mixtures (C^*O_2 = inert carbon dioxide containing some $C^{14}O_2$) by using pairs of counters that are identical in construction except for the length of the cathodes. The suitability of various equations proposed for calculating the true counting rate, C_T, from the resolving time, t_r, and the observed counting rate, C_o, is evaluated from experimental measurements of C_o and t_r and is presented graphically. A value of $5\,370 \pm 200$ years for the half-life is obtained from these measurements. By comparison with other results, it is estimated that the most probable value is $5\,400 \pm 200$ years. A.

539.163.1

5693. New radioactive isotopes produced by nuclear photo-disintegration. F. D. S. BUTEMENT. *Proc. Phys. Soc., Lond. A*, **64**, 395–403 (*April*, 1951).

Photonuclear (γ, n) and (γ, p) reactions produced by 23 MeV X-rays from a synchrotron have been used to prepare new radioactive isotopes, the method being particularly advantageous for neutron-excess isotopes in the region $Z = 63$ to 79. Whenever possible the isotopes were chemically identified. The isotopes prepared were: As^{79}, $Sm^{143 \text{ or } 146}$, Eu^{150}, Eu^{159} or Gd^m, $Tb^{162 \text{ or } 163}$, Er^{163} or $Ho^{167 \text{ or } 169}$, $Tm^{172 \text{ or } 173 \text{ or } 175}$, $Lu^{178 \text{ or } 179}$, $Ta^{183, 185}$, $Re^{189 \text{ or } 191}$, $Ir^{195 \text{ or } 197}$, $Au^{201 \text{ or } 203}$, Gd^{159}, Au^{200}. A.

539.163.1

5694. Radioactive Hg^{203} and Hg^{205}. W. S. LYON. Letter in *Phys. Rev.*, **82**, 276 (*April* 15, 1951).

Assignments of the 46-day activity to Hg^{203}, and the 5 mm activity to Hg^{205} were confirmed, using enriched Hg samples. The radiations of the isotopes were studied, and the activation cross-sections measured.

B. ROSE

539.163.1

5695. Further search for nuclear transitions with lifetimes between 3×10^{-9} sec and 10^{-7} sec. W. E. WRIGHT AND M. DEUTSCH. Letter in *Phys. Rev.*, **82**, 277 (*April* 15, 1951).

Metastable states of Br^{80}, Xe^{131}, Gd^{152}, Ho^{165}, W^{182}, Os^{188}, Pt^{192} and Hg^{199} were investigated: all have half-lives $< 5 \times 10^{-9}$ sec. A. O. STANESBY

539.163.1 : 550.93

5696. Half-life of I^{129} and the age of the elements. S. KATCOFF, O. A. SCHAEFFER AND J. M. HASTINGS. *Phys. Rev.*, **82**, 688–90 (*June* 1, 1951).

The specific activities of several samples of methyl iodide containing I^{129} were measured with proportional counters, and the ratios of I^{129} to I^{127} were determined with a 60° sector type mass spectrometer. The half-life of I^{129} was found to be $(1·72 \pm 0·09) \times 10^7$ years. The time interval between the formation of the elements and the formation of the earth calculated from this value is $2·7 \times 10^8$ years. It was assumed that most of the Xe^{129} present on the earth at present originated from decay of I^{129} after the formation of the earth and that the original cosmic abundance of I^{129} was about equal to that of the stable I^{127}. A.

539.163.2

5697. Radioactive strontium produced by deuteron bombardment of rubidium. M. TER-POGOSSIAN AND F. T. PORTER. Letter in *Phys. Rev.*, **81**, 1057–8 (*March* 15, 1951).

This was shown to decay (65 day $\frac{1}{2}$-life) by orbital electron capture without β^+ emission, and the 513 keV radiation to be true γ-radiation. A re-assignment of one of the shorter lived activities was found necessary. W. J. SWIATECKI

539.163.2

5698. Decay of the mercury isomer Hg^{197}. O. HUBER, F. HUMBEL, H. SCHNEIDER, A. DE SHALIT AND W. ZÜNTI. *Helv. Phys. Acta*, **24** (*No.* 2) 127–52 (1951) *In German.*

The radiation from Hg^{197}(23 h) and Hg^{197}(65 h) has been investigated and it is shown that a genetic relation exists between these two states. From results of coincidence measurements (using G.M.-counters) between the conversion electrons, together with the results of the lens spectrometer, the conversion coefficients of the γ-transition in Hg^{197} have been determined. By another coincidence technique (described below) within the lens spectrometer the γ-transitions from the excited Au^{197} levels were studied. It is shown that the isomer Au^{197*} (7·4 sec) decays by the emission of three γ-rays in cascade; the conversion coefficients of these γ-rays are evaluated. A decay scheme for Hg^{197} (23 h + 65 h) is proposed. A.

539.163.2

5699. The identification of W^{188} formed in neutron-activated tungsten by a chemical separation of Re^{188}. M. LINDNER AND J. S. COLEMAN. *J. Amer. Chem. Soc.*, **73**, 1610–11 (*April*, 1951).

A new radioisotope of W, mass 188, which was formed by successive neutron capture by the heaviest stable W isotope, W^{186}, has been indirectly established in the presence of very large levels of other radio-tungsten isotopes. This was accomplished by observing the activity of the known Re^{188} which arises as a result of the decay of the W^{188}. The chemical method consisted of precipitation of the W as oxide and isolation of the Re as tetraphenyl-arsonium perrhenate. The equilibrium level of separable Re activity was found to diminish with a half-life of 65 days, which is thus the half-life of the W^{188}. The isolation of the Re^{188} in pure form led to a new value of the half-life of this isotope of 16·9 hr as contrasted to previous values of 18 and 18·9 hr. A.

539.163.2

5700. Short-lived krypton isotopes and their daughter substances. O. KOFOED-HANSEN AND K. O. NIELSEN. Letter in *Phys. Rev.*, **82**, 96–7 (*April* 1, 1951)

Half-lives and max. β-ray energies of Kr^{89-91}, Rb^{90-1} are given. Rb^{91} has two isomeric states (100 sec and 4 min).

539.163.2

5701. The disintegration of As^{74}. S. JOHANSSON, Y. CAUCHOIS AND K. SIEGBAHN. Letter in *Phys. Rev.*, **82**, 275 (*April* 15, 1951).

Measurements on the β^+, β^- and γ-radiations are reported, and a decay scheme suggested. B. ROSE

539.163.2

5702. Delayed coincidence angular correlations. S. P. LLOYD. Letter in *Phys. Rev.*, **82**, 277 (*April* 15, 1951).

Formulae are derived for the angular correlations between two particles emitted by a nucleus in a magnetic field as a function of the time interval between the emissions. W. J. SWIATECKI

539.163.2

5703. Beta-alpha-correlation in the disintegration of Li^8. J. W. GARDNER. Letter in *Phys. Rev.*, **82**, 283 (*April* 15, 1951).

539.163.2

5704. Neutron deficient isotopes of lanthanum. M. M. GRANSDEN AND W. S. BOYLE. Letter in *Phys. Rev.*, **82**, 447 (*May* 1, 1951).

Two new isotopes $La^{131,132}$ ($\frac{1}{2}$-lives 58 min and 4·5 hr respectively) were separated in a mass spectrograph and their radiations studied. W. J. SWIATECKI

539.163.2

5705. Radiations from I^{126*}. M. L. PERLMAN AND G. FRIEDLANDER. Letter in *Phys. Rev.*, **82**, 449 (*May* 1, 1951).

Preliminary results of decay scheme investigations (β- and γ-rays). W. J. SWIATECKI

539.163.2

5706. Radiations of UY. A. H. JAFFEY, J. LERNER AND S. WARSHAW. *Phys. Rev.*, **82**, 498–501 (*May* 15, 1951).

The radiations of UY have been examined by absorption curve techniques. Among the radiations are: (1) 0·2 MeV beta, (2) *L* X-rays, (3) 35 keV gamma-ray, (4) soft electronic component, probably conversion electrons about 50 keV, (5) soft quantum component, probably *M* X-rays, and (6) two harder gamma-rays, 65 to 75 keV and about 100 keV. On abundance and coincidence considerations, a tentative decay scheme is suggested which includes a 0·2 MeV beta followed by 35 and 65 keV gamma-rays in cascade with a 100 keV cross-over transition. The half-life was found to be $25{\cdot}6_4 \pm 0{\cdot}1$ hr. A.

539.163.2

5707. Disintegration scheme of Re^{186}. F. R. METZGER AND R. D. HILL. *Phys. Rev.*, **82**, 646–50 (*June* 1, 1951).

The radiations from Re^{186} have been studied by means of beta-ray spectrometers and scintillation counting techniques. It has been found that Re^{186} decays both by beta-emission and by *K*-capture. Three partial beta-ray spectra of 1·07, 0·93 and 0·3 MeV maximum energies have abundances of 76, 19 and 0·4%, respectively, and lead to the ground state and 137 and 627 keV excited states of Os^{186}. Two *K*-capture branches of 3 and 2% abundances lead to the ground state and a 123 keV excited state of W^{186}. Transitions between these states give rise to electric quadrupole gamma-rays of 137 and 123 keV and other relatively weak magnetic dipole gamma-rays of 764 and 627 keV energy. A decay scheme in which spins and parities are assigned to all the levels is proposed. A.

539.163.2 : 539.185

5708. Radioactivity induced in iridium by neutron capture. J. M. Cork, J. M. LeBlanc, A. E. Stoddard, W. J. Childs, C. E. Branyan and D. W. Martin. Letter in *Phys. Rev.*, **82,** 258 (*April* 15, 1951).

Forty-nine electron lines were observed from 78 day Ir^{192} which decays by *K*-capture as well as by β-emission. Nuclear level schemes are suggested for the daughter nuclei Os^{192} and Pt^{192}. A. O. STANESBY

539.164.1

5709. The range-energy relation for slow alpha-particles in air. J. M. Freeman and W. E. Burcham. Letter in *Phil. Mag.*, **42,** 434–7 (*April*, 1951).

Range measurements of α-particles of known energy between 1 and 2·3 MeV closely conform to recently published relations [Abstr. 5225, 7465 (1950)].

539.164.2

5710. On the systematics of even-even alpha-emitters. I. Kaplan. *Phys. Rev.*, **81,** 962–8 (*March* 15, 1951).

The systematics of even-even alpha-emitters are studied. Empirical relationships are found, of the form $\log \lambda = a + b/v$, Z constant, for values of $Z = 84$, 86, 88, 90, 92 and 94. For these cases, the relationships found represent a more precise empirical correlation of alpha-energy and disintegration constant than does the Geiger–Nuttall rule. Relationships of the form $\log \lambda = A + B/v$, $(A - 2Z)$ constant, exist for members of different partial radioactive series and are related to the disintegration schemes of the Th and U families. Values of the nuclear radii and internal potentials are calculated from the rigorous form of the Gamow–Condon–Gurney theory. The radii of "normal" even-even alpha-emitters can be presented by $r_0 = 1{\cdot}57A^{\frac{1}{3}} \times 10^{-13}$ cm, while the internal potential, U, can be represented by $E - U = 0{\cdot}52$ MeV. The latter relationship is an indication of the approximate constancy, for the different nuclei, of the logarithmic derivative of the radial wave function at the boundary of the nucleus. The empirical relations $\log \lambda = a + b/v$, Z constant, are compared with theory; and the significance of the comparison is discussed. The values of the half-lives of Th^{224}, Ra^{220} and Em^{216} are predicted. The isotopes of Po and Em, which show departures from "normal behaviour," are considered. A.

539.164.2

5711. The noncentral electric interaction in alpha-radioactivity. M. A. Preston. *Phys. Rev.*, **82,** 515–20 (*May* 15, 1951).

Apart from the penetrability of the Coulomb potential barrier, which determines the order of magnitude of the intensity of α-decay, there are 3 secondary effects which alter the decay constant: angular momentum, "formation" prohibition as discussed by Perlman, Ghiorso and Seaborg, and noncentral electric interaction with the product nucleus. The general theory of this last effect is discussed and its magnitude estimated. It is suggested that it may be of considerable importance in determining the intensity of highly forbidden ground state transitions described by Perlman, Ghiorso and Seaborg. Further numerical work would be desirable. A.

539.164.7

5712. The stopping power of liquid water. R. K. Appleyard. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 443–5 (1951).

Experiments are described in which the stopping power of liquid water relative to air has been re determined for 5 MeV α-particles, using only a limited portion of the range. The results confirm those of earlier experimenters, who concluded that liquid water did not obey the Bragg Law. A.

539.165

5713. Complex beta-decay in ^{88}rubidium. K. Geiger. Note in *Z. Naturforsch.*, **6a,** 54–5 (*Jan.* 1951) *In German.*

The beta-radiations of Rb^{88} were examined by absorption in Al in comparison with the 4·91 MeV Cl^{38} spectrum, and β–γ and γ–γ coincidence measurements were also made. The β-particle groups found were β_1 ($E_{max} = 5{\cdot}10 \pm 0{\cdot}10$ MeV), no γ-rays; β_2 ($3{\cdot}8 \pm 0{\cdot}5$ MeV) and β_3 ($1{\cdot}8 \pm 0{\cdot}2$ MeV), both associated with γ-rays, β_3 having 2 γ-rays in cascade; the relative intensities were 5 : 2 : 2. The mean energy of the 3 expected γ-rays was 2·2 MeV. See also Abstr. 2974 (1951). A. O. STANESBY

539.165

5714. Disintegration of the 15-day osmium. K. Kondaiah. *Ark. Fys.*, **3,** *Paper* 4, 47–51 (1951).

A Fermi plot of a portion of the β-spectrum indicates an end point at 143 ± 2 keV. There is no evidence for a softer β-spectrum. Photo peaks of γ-rays of energies 128 ± 1 and 42 ± 1 keV were observed. B. ROSE

539.165

5715. Radiations from Zr^{89}. K. Shure and M. Deutsch. Letter in *Phys. Rev.*, **82,** 122 (*April* 1, 1951).

79·3 hr Zr^{89} has a max. positron energy of 905 keV and a conversion line of 910 keV. No β–γ or γ–γ coincidences were found, indicating that the level emitting the conversion electrons has a lifetime $\geqslant 10^{-7}$ sec. The conversion coefficient was estimated as 0·5%.

539.165

5716. The twice-forbidden transition of Cs^{137} and the law of beta-decay. L. M. Langer and R. J. D. Moffat. *Phys. Rev.*, **82,** 635–8 (*June* 1, 1951).

The shape of the beta-spectrum of the direct 1·17 MeV, 8% abundant transition between the $g_{7/2}$ ground state of Cs^{137} and the $d_{3/2}$ ground level of Ba^{137} has been studied in detail in a magnetic spectrometer. The shape of the spectrum can be adequately described by a twice-forbidden factor, C_{2T}, resulting from the tensor form of interaction. Neither the axial vector form nor the combination S–A–P are capable of accounting for the data. A.

539.165

5717. β-recoil experiments with Kr^{89}. O. Kofoed-Hansen and P. Kristensen. Letter in *Phys. Rev.*, **82,** 96 (*April* 1, 1951).

Max. recoil energy 115 ± 5 eV (max. β-energy $3{\cdot}9 \pm 0{\cdot}1$ MeV). Average value of energy divided by the charge of the recoils 58 ± 2 eV. Kr^{89} $\frac{1}{2}$-life 3·14 min. Relative fission yield of mass numbers 88 and 89, $r89/r88 = 1{\cdot}5 \pm 0{\cdot}2$.

539.165 : 530.145

5718. On radiative corrections to the angular correlation in internal pair creation. R. H. DALITZ. *Proc. Roy. Soc. A*, **206**, 521–38 (*May* 22, 1951).

A detailed discussion of the radiative corrections to internal pair creation is given, including the effect of all internal bremsstrahlung. Numerical results are presented for the 6·04 MeV zero-zero transition in O^{16}, for which the effects of the Coulomb field, of the nuclear structure and of the non-Coulomb forces are shown to be negligible. The total correction amounts to a decrease of 0·7% in the total pair emission, and varies quite slowly with the angle between the pair, except near $\theta = 0°$ (due to the interaction between the pair—the number of pairs with separation $< 10°$ is increased by 2·3%) and $\theta = 180°$ (an increase of 5% in pair emission due to pairs accompanied by a hard photon). A.

539.165 : 539.153

Orbital perturbation effects in beta-decay. *See Abstr.* 5674

539.165.08

5719. A simple laboratory setup for rapid measurement of β-ray dosages above 1 rep/sec. J. S. KROHMER AND W. A. MCCARTHY. *Science*, **113**, 360–1 (*March* 30, 1951).

The two parallel plates of the ionization chamber described, are constructed of "lucite," a tissue-simulating insulator, coated with carbon. The collecting (lower) electrode is 3·9 mm in dia. and surrounded by a guard ring. Accurate adjustment of plate separation is made by 3 micrometer supports to the upper plate. Ionization current is measured directly by a micro-microammeter (registering down to 10^{-14} amp) and recorded on a 0–10 mV Brown strip-chart recorder. Insertion of sheets of "lucite" between the β-ray source and the upper plate, allows dosage measurement ⌊ at any equivalent tissue depth. Ionization current for each required position of the source, is plotted against electrode spacing down to 0·2 mm, the ionization per unit volume at zero separation being extrapolated. Using the known plate area, absolute dosage from the β-rays is then calculated. D. V. MABBS

539.165.2

5720. On the theory of beta-radioactivity. IV. The polarization of beta-rays emitted by aligned nuclei in allowed transitions. H. A. TOLHOEK AND S. R. DE GROOT. *Physica*, **17**, 81–97 (*Feb.*, 1951).

See Abstr. 4669 (1951) for Pt III. The consequences of alignment of nuclei which show allowed β-transitions are investigated. A general formula is derived for the transition probability of an allowed β-transition, in which the direction of emission of electron and neutrino, the polarization of the electron and the orientation of the nuclear spin are taken into account. The calculations have been made for a Hamiltonian for the β-interaction, which is an arbitrary "mixture" of the five invariants of the Dirac theory. The influence of the nuclear charge has, however, been neglected. From this formula the following results are obtained: The angular distribution of the β-radiation remains spherically symmetric if the nuclei are aligned, so that the alignment cannot be detected in this way. The emitted β-radiation is polarized and the degree of polarization follows from the general formula. If the special case is taken that the interaction Hamiltonian is of the tensor or the axial vector type and if the β-rays are emitted perpendicular to the direction of the nuclear spin of completely aligned nuclei with nuclear spin j_i, the degree of polarization is given by: (*a*) $1/E$, if $j_i = j_f + 1$, (*b*) $1/E(j_i + 1)$, if $j_i = j_f$, (*c*) $j_i/E(j_i + 1)$, if $j_i = j_f - 1$. (E is the relativistic energy of the electrons, $E \simeq 1$ for small kinetic energies; j_f gives the spin of the final nucleus.) A.

539.165.2

5721. Note on higher order effects in beta-decay. E. MERZBACHER. *Phys. Rev.*, **81**, 942–5 (*March* 15, 1951).

The exchange of a virtual light quantum between an electron and the nucleus which emits the electron in beta-decay is considered. The conditions are deduced under which this process can modify the decay probabilities and the selection rules. The special case of "strictly forbidden" transitions is discussed. A.

539.165.2

5722. On the type of interaction in β-decay. S. A. MOSZKOWSKI. Letter in *Phys. Rev.*, **82**, 118 (*April* 1, 1951).

From the matrix elements for the decay of special light nuclei it is concluded that β-decay is primarily determined by a Gamow–Teller term, a small Fermi term and an unknown pseudo-scalar interaction, assuming a theory of the nuclei based on supermultiplets. G. J. KYNCH

539.165.2

5723. Electron-neutrino angular correlation. E. GREULING AND M. L. MEEKS. *Phys. Rev.*, **82**, 531–7 (*May* 15, 1951).

Angular correlation functions are calculated for allowed and first forbidden beta-decay transitions including the effect of the nuclear Coulomb field. The process of beta-decay is viewed as a kind of scattering in which an incident negative energy neutrino is transformed by the Fermi interaction in to scattered electron in a positive energy state. The outgoing electronic wave function is calculated, and the angular correlation functions are determined from the angular dependent electron probability current through sections of a sphere at large distances from the nucleus. For allowed transitions, the angular correlation is found to be independent of atomic number and identical with the results of previous calculations which assumed $Z = 0$. The $Z = 0$ approximation is shown to be unreliable for first forbidden transitions in which correlation terms proportional to the 1st and 2nd powers of the potential energy of an electron at the surface of the nucleus appear. This effect is important even for moderately heavy nuclei. A.

539.166

5724. On the production of γ-rays accompanied with the absorption of π^--meson by a proton. I. S. OGAWA AND E. YAMADA. *Progr. Theor. Phys.*, **5**, 977–82 (*Nov.–Dec.*, 1950).

Of the 3 possibilities, (*a*) $\pi^- + P \rightarrow N + \gamma$, (*b*) $\pi^- + P \rightarrow N + 2\gamma$, (*c*) $\pi^- + P \rightarrow N + \pi^\circ \rightarrow N + 2\gamma$ investigated in connection with the observed

γ-rays of 60 and 130 MeV, (*b*) is calculated to be unimportant. (π^-, π° scalar or pseudo-scalar with scalar or ps. scalar couplings). The shape of the 60 MeV "line" favours a scalar and excludes a vector π°. W. J. SWIATECKI

539.166

5725. Gamma-ray spectrum of K^{40}. M. L. GOOD. Letter in *Phys. Rev.*, **81**, 891–2 (*March* 1, 1951).

The energy was determined to be $1{\cdot}459 \pm 0{\cdot}007$ MeV by means of a scintillation spectrometer, using the radiation from Co^{60} as a standard. B. ROSE

539.166

5726. Radioactivity of cerium. R. D. HILL. Letter in *Phys. Rev.*, **82**, 449 (*May* 1, 1951).

Gamma-rays of 145, 165·5 and 257 keV were found and assigned to $Ce^{141, 139, 137}$ respectively. W. J. SWIATECKI

539.166

5727. Coincidence studies in the radiations from Ba^{131}. W. H. CUFFEY. Letter in *Phys. Rev.*, **82**, 461 (*May* 1, 1951).

These confirm existing findings and show that the γ-ray at 0·46 MeV is in cascade with lower energy γ-rays. W. J. SWIATECKI

539.166 : 539.172.4

5728. Neutron capture γ-rays from lead and bismuth. B. B. KINSEY, G. A. BARTHOLOMEW AND W. H. WALKER. *Phys. Rev.*, **82**, 380–8 (*May* 1, 1951).

Only two strong γ-rays have been detected with a pair spectrometer during the bombardment of Pb by thermal neutrons. The weaker ($6{\cdot}734 \pm 0{\cdot}008$ MeV) is due to capture in Pb^{206} and the stronger ($7{\cdot}380 \pm 0{\cdot}008$ MeV) is due to capture in Pb^{207}. Apart from a very weak ray ($6{\cdot}90 \pm 0{\cdot}05$ MeV) no other radiation has been detected. The 6·9 MeV ray may be due to the excitation of a hitherto unknown state in Pb^{208}, or to an impurity. Bi produces a γ-ray with an energy of $4{\cdot}170 \pm 0{\cdot}015$ MeV. The breadth of the coincidence peak is about 70 keV greater than would be expected for a homogeneous radiation. The γ-rays revealed by the coincidence spectra of Pb and Bi have intensities of about one quantum per capture. The binding energies of four neutrons in Pb^{210} (RaD) have been calculated using the above experimental data and compared with that computed from the decay of Pb^{210} and its products. The latter exceeds the former by $0{\cdot}37 \pm 0{\cdot}07$ MeV. The origin of this discrepancy is discussed. The binding energy of Pb^{210} is shown to be less than the energy of disintegration of RaC″, and experiments are described which prove that if neutrons are produced in the decay of the latter, the yield is less than one neutron per 250 disintegrations. No γ-ray with the binding energy of Pb^{205} ($6{\cdot}4 \pm 0{\cdot}2$ MeV) was detected. Pb^{205} is shown to be unstable against electron capture to Tl^{205} by about 300 keV. Both Bi^{208} and Bi^{209} are shown to be unstable for α-decay by 3·25 MeV. A.

NUCLEAR REACTIONS 539.17

539.17

5729. Conservation of angular momentum in the statistical theory of nuclear reactions. L. WOLFENSTEIN. *Phys. Rev.*, **82**, 690–6 (*June* 1, 1951).

The conservation of total angular momentum *J*, *z*-component of angular momentum *m*, and parity *p* are considered in connection with the statistical theory of nuclear reactions. Results are obtained for the angular distribution of a single group of outgoing particles and for the cross-section as a function of the spin of the residual nucleus. The energy and angular distributions are also considered for the case in which many groups are observed simultaneously. The density of nuclear states as a function of spin affects results appreciably. A.

539.17

5730. On the nuclear stars. Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **5**, 904–6 (*Sept.–Oct.*, 1950).

Some recent papers on nuclear evaporation and star production are critically assessed, e.g. [Abstr. 3434 (1949), 4354 (1950)]. 21 refs. W. J. SWIATECKI

539.17.08 : 778.3

5731. Nuclear emulsion scanning mechanism. A. V. MASKET AND L. B. WILLIAMS. Note in *Rev. Sci. Instrum.*, **22**, 113–14 (*Feb.*, 1951).

An automatic scanning mechanism which fits on to a standard microscope is described. The emulsion is scanned twice in depth for each field of view passing the objective. A. C. COATES

539.17.08 : 778.3

5732. The measurement of the scattering of tracks in photographic emulsions; elimination of spurious scattering. B. D'ESPAGNAT. *C.R. Acad. Sci., Paris*, **232**, 800–2 (*Feb.* 26, 1951) *In French.*

The observed small-angle scattering can be considered to be made up of two components, that due to true scattering and that due to spurious scattering. Successive scattering angles have one direction in common and therefore they are not statistically independent. The correlation between successive true scattering angles is not the same as that between successive spurious scattering angles and this fact enables the spurious scattering to be eliminated. A correction term can be applied to allow for the effect of distortion due to the shrinkage of the emulsion on processing. A. C. COATES

539.17.08 : 778.3

5733. Discussion of a particular method of measuring the multiple scattering of high-energy particles in a photographic emulsion. C. MABBOUX. *C.R. Acad. Sci., Paris*, **232**, 1091–2 (*March* 12, 1951) *In French.*

Measurements of small-angle scattering are usually made in a plane parallel to the emulsion. They can also be made in a plane perpendicular to that of the emulsion, and since the two sets of scattering angles are independent this latter method can serve to increase the number of measurements on short tracks. A. C. COATES

539.172

5734. Fission of medium weight elements. R. E. BATZEL AND G. T. SEABORG. *Phys. Rev.*, **82**, 607–15 (*June* 1, 1951).

Evidence is presented here which indicates that large fragments (much larger than alpha-particles) are emitted among the competitive products of transmutation throughout the entire range of atomic numbers of the elements. Threshold considerations for the observed nuclear reactions show that the reactions are observed with small cross-sections well below the threshold for spallation reactions in which the maximum number of alpha-particles are considered as being emitted from the excited nucleus. The calculated thresholds include the mass difference between the reactants and the products and the excitation energy which the product particles or fragments must have in order to pass over the Coulombic barrier. Preliminary experiments on the ranges of recoil fragments from Cu irradiated with 340 MeV protons give additional evidence for the emission of heavy fragments. It is suggested that the term "fission" is proper for such reactions, throughout the entire range of atomic numbers, in which the nucleus is split essentially into pieces of comparable weight. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 5520–1, 5536–8, 5541–4

539.172 : 541.126

5735. Evidence of nuclear transmutation in the course of explosion of shaped charges with lined cavity. Z. FONBERG. Letter in *J. Chem. Phys.*, **19**, 383 (*March*, 1951).

Silver and other metal plates exposed to the action of these charges indicated increased radioactivity; Ag^{108} was probably formed due to the explosion. J. JACOBS

539.172

5736. On the stars of light nuclei. Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **5**, 896–7 (*Sept.–Oct.*, 1950).

Fermi's statistical method [Abstr. 3336 (1951)] is applied to star production by π-meson capture and by proton bombardment. Agreement with experiment is obtained. E. P. GEORGE

539.172

5737. Determination of the number of neutrons associated with the stoppage of negative μ-mesons in lead. G. GROETZINGER, M. J. BERGER AND G. W. MCCLURE. *Phys. Rev.*, **81**, 969–72 (*March* 15, 1951).

Negative mesons (at sea level and therefore assumed to be μ-mesons) were focused on to a lead absorber by means of a magnetic cosmic-ray spectrometer. The number of μ-mesons which stopped in the absorber was determined with an anticoincidence arrangement. Neutrons issuing from the absorber were registered during intervals of from 5 to 135 μsec after each such stoppage by a counting system consisting of enriched-BF_3 counters surrounded by 8 cm of paraffin, whose efficiency was measured with the help of a calibrated Na–Be source of $\simeq$ 1-MeV photoneutrons. For 5 500 stopped μ-mesons, the average number of neutrons emitted per μ-meson stoppage was found to be $1{\cdot}96 \pm 0{\cdot}72$. This result is consistent with the assumption that a neutrino (or light neutral meson) is emitted in the interaction between a μ-meson and a nucleon. A.

539.172

5738. On the nuclear interaction of π^- mesons in nuclear emulsions. G. BERNARDINI, E. T. BOOTH, L. LEDERMAN AND J. TINLOT. Letter in *Phys. Rev.*, **82**, 105 (*April* 1, 1951).

Reports observations of interactions of mesons in the energy range 70–90 MeV. The mean free path for the production of inelastic scatterings, stars and stoppings in emulsion is 18 ± 4 cm. E. P. GEORGE

539.172

5739. On the γ-ray spectrum resulting from the absorption of π^- mesons in deuterium. K. M. WATSON AND R. N. STUART. *Phys. Rev.*, **82**, 738–44 (*June* 1, 1951).

The γ-ray spectrum resulting from the reaction $\pi^- + D \rightarrow 2n + \gamma$ has been shown to depend strongly on the nature of the n–n interaction and has been calculated for several values of the n–n scattering length. A comparison of the theoretical cross-section with preliminary experiments by Aamodt, Panofsky and Phillips indicates: (1) an upper limit of approximately 200 keV can be put on the binding energy of the di-neutron; (2) photomeson production involves an interaction with the nucleon spin. A.

539.172.1

5740. Energy levels in Li^7. H. E. GOVE AND J. A. HARVEY. *Phys. Rev.*, **82**, 658–63 (*June* 1, 1951).

Inelastic collisions of protons, deuterons and alphas of energies 7·9, 14 and 31 MeV, respectively, with Li^7, and the $Be^9(d\alpha)$ reaction all show a new level in Li^7, mean $Ex = 4{\cdot}77 \pm 0{\cdot}01$ MeV. In all cases the differential range spectra of the emitted groups were measured in Al absorbers using a gated triple proportional counter. In addition, a low energy group was found in the $Be^9(d,\alpha)$ reaction which would correspond to a level in Li^7 at $7{\cdot}50 \pm 0{\cdot}17$ MeV. No corresponding group was observed in the inelastic scattering reactions. Possible explanations of this are given. Preliminary results on the $Li^7(d,t)Li^{6*}$ and the $Li^6(p,p')Li^{6*}$ reactions indicate a level in Li^6 at $2{\cdot}15 \pm 0{\cdot}2$ MeV. There is also evidence for two levels in Li^8 at excitation energies of $1{\cdot}0 \pm 0{\cdot}2$ and $2{\cdot}3 \pm 0{\cdot}2$ MeV from the $Li^7(d,p)Li^{8*}$ reaction. A.

539.172.11

5741. Excitation function of $C^{14}(\alpha,p)N^{17}$. K. H. SUN, B. JENNINGS, W. E. SHOUPP AND A. J. ALLEN. Letter in *Phys. Rev.*, **82**, 267 (*April* 15, 1951).

This was measured by monitoring the neutrons from the decay of N^{17}. The cross-section rises to a maximum of 6×10^{-26} cm^2 at 27 MeV, falling off above this, probably due to competing reactions.

J. HUGHES

539.172.11

5742. Relative energy and angle distribution of low energy π^- mesons from 390-MeV alpha-particles on carbon. μ^- meson endings. S. B. JONES AND R. S. WHITE. *Phys. Rev.*, **82**, 374–7 (*May* 1, 1951).

A part of the energy spectrum of π^- mesons generated with the Berkeley 184-inch cyclotron by

the bombardment of 0·1 g/cm² of C with 390 MeV alpha-particles has been investigated. The π^- mesons were registered in nuclear emulsions. Relative values for the numbers of π^- mesons with energies up to 14 MeV were determined at angles up to 60° with the beam direction. The maximum of the energy distribution function apparently occurs at an energy > 12 MeV. Some information about the μ^- meson endings is obtained from a region of the emulsion forbidden to π^- mesons except for pronounced scattering. A.

539.172.13

5743. The production of neutrons by high energy protons. J. M. Cassels, T. C. Randle, T. G. Pickavance and A. E. Taylor. Letter in *Phil. Mag.*, **42**, 215–19 (*Feb.*, 1951).

Measurements were made of the energy spectra (above 60 MeV) of neutrons produced at 2·5° by 171 MeV proton bombardment of 4 elements, using a 110 in cyclotron. Recoil protons from polythene and carbon radiators were counted differentially as a function of absorber thickness in a triple coincidence telescope. Each spectrum shows a peak at 130 to 150 MeV neutron energy, and the production cross-sections are 91, 47, 122 and 1 520 millibarn for Be, C, Al and U respectively, with estimated error a factor 1·5 either way. Multiple traversals of the beam through the targets were taken into account in the cross-section measurements, and the values for Be and C (at 5°) were also measured by counting recoil protons from all neutrons above 60 MeV; the results are 99 ± 19 and 72 ± 15 millibarns respectively.

T. G. PICKAVANCE

539.172.13

5744. Angular distribution of neutrons from the bombardment of Be by 340-MeV protons. J. DeJuren. Letter in *Phys. Rev.*, **81**, 458 (*Feb.* 1, 1951).

This was measured using a Bi fission chamber. The half width of the forward peak was 49°, compared with 54° obtained by R. D. Miller, Sewell and Wright [Abstr. 4702 (1951)] using the C(*n*,2*n*) reaction to detect the neutrons. J. HUGHES

539.172.13

5745. On the production of π^+ mesons in proton–proton collisions (case of deuteron creation). J. Prentki. *C.R. Acad. Sci., Paris*, **232**, 940–2 (*March* 5, 1951) *In French.*

It is suggested that the experimentally found maximum near the upper end of the energy spectrum of the π^+ mesons is associated with the process $P + P \rightarrow D + \pi^+$. By regarding this as the inverse of meso-disintegration of the deuteron the cross-section is found to be $1{\cdot}32 \times 10^{-28}$ cm² which confirms the importance of this process. More detailed experiments on the relevant portion of the energy spectrum are called for. W. J. SWIATECKI

539.172.13

5746. The production of mesons by protons on deuterons. H. P. Noyes. *Phys. Rev.*, **81**, 924–9 (*March* 15, 1951).

An attempt is made to predict the energy and angular distribution of charged mesons to be expected from the bombardment of deuterium by 345 MeV protons assuming that the cross-section for production in two-nucleon collisions is known. The problem is simplified by assuming that the third particle enters the reaction only by giving to the struck particle a momentum distribution at some time prior to the meson production, by carrying off the complementary momentum, and by limiting the states available through the exclusion principle. The possibility of the reformation of a deuteron more than doubles the cross-section for the production of positive if it occurs. Hence the positive–negative ratio offers an experimental means of determining the spin-dependence of positive meson production in the final state, assuming that the ratio of *p–n* to *p–p* production is known. Alternatively, this approach offers a method for a rough determination of the *p–n* meson production cross-section using high energy proton beams. A.

539.172.13

5747. Observations on lithium and beryllium nuclei ejected from heavy nuclei by high energy particles. L. Marquez and I. Perlman. *Phys. Rev.*, **81**, 953–7 (*March* 15, 1951).

The yields of Be^7 produced by 335 MeV protons on nuclei of different atomic number have been determined and found to decrease with increasing atomic number. Reactions are described in which the irradiation of an element with protons or alpha-particles results in products higher by three in atomic number. These reactions are interpreted tentatively as second-order processes in which the initial step is the production of high energy Li nuclei, which in turn cause nuclear reactions of the type (Li,*xn*). From the observed over-all yields, deductions are made as to the cross-sections for the separate steps. A.

539.172.13

5748. Elastically scattered protons from carbon. G. Goldhaber and R. M. Williamson. *Phys. Rev.*, **82**, 495–8 (*May* 15, 1951).

The excited states of N^{13} were investigated by use of the $C^{12}(p,p)$ reaction. Only the two resonances, at 465 keV and 1·7 MeV proton energies, previously known from the $C^{12}(p,\gamma)N^{13}$ reaction were found. The energy region covered was from 0·3 to 4·0 MeV proton bombarding energy. The elastically scattered protons were observed by the use of a 90° magnetic analyser at an angle of 164° to the incident beam. The intensities at the resonances show that the 465 keV level has $J = \frac{1}{2}$ and that the 1·7 MeV level has probably $J = 3/2$ or $5/2$. A.

539.172.13

5749. The gamma-ray yield of phosphorus bombarded with protons. G. R. Grove and J. N. Cooper. *Phys. Rev.*, **82**, 505–9 (*May* 15, 1951).

Protons from a van de Graaff generator have been used to bombard P^{31}, and the reaction $P^{31}(p,\gamma)S^{32}$ has been studied. The gamma-ray yield has been measured, as a function of proton energy, in the region between 400 and 1 700 keV. Maxima in the gamma-ray yield occur at proton energies of 440, 550, 650, 817, 890, 1 067, 1 100, 1 129, 1 162, 1 265, 1 421, 1 458, 1 495, 1 538, 1 583 and 1 610 keV. Absorption measurements of the gamma-rays from the strongest resonance, that at 1 265 keV, indicate a quantum

energy of 12 MeV, which is consistent with the assumption that the compound nucleus decays to the ground state by a single transition. A.

539.172.13

5750. Alpha-particles from the proton bombardment of oxygen-18. J. SEED. Letter in *Phil. Mag.*, **42**, 566–8 (*May*, 1951).

The excitation function showed resonances at 640 and 850 keV. From measurements of the α-particle energy at the higher resonance, a Q-value of $3{\cdot}96 \pm 0{\cdot}04$ MeV was obtained for the transition to the N^{15} ground state, suggesting levels at 8.59 and 8·80 MeV in the F^{19} nucleus. No evidence was found for an α-particle group corresponding to transitions to N^{15} excited states.

539.172.13

5751. Carrier-free radioisotopes from cyclotron targets. XVI. Preparation and isolation of Pd^{103} from rhodium. J. D. GILE, H. R. HAYMOND, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **19**, 660–1 (*May*, 1951).

Abstr. 4701 (1951) part XV.

539.172.13

5752. Stars in photographic emulsions initiated by protons. L. S. GERMAIN. *Phys. Rev.*, **82**, 596–7 (*June* 1, 1951).

Both the average number of prongs per star and the cross-section for star production were found to increase with increasing proton energy. A.

539.172.13

5753. The $Mn^{55}(p,n)Fe^{55}$ neutron spectrum. P. H. STELSON AND W. M. PRESTON. *Phys. Rev.*, **82**, 655–7 (*June* 1, 1951).

A thin (20-keV) target of Mn on a Ta backing was bombarded by monoenergetic protons of 2·97, 3·42 and 3·77 MeV. Nuclear emulsion plates (Eastman NTB, 200 microns thickness) were mounted 15 cm from the target at 0° and 90° with respect to the incident proton beam. The resulting neutron spectra, obtained from the analysis of 2 400 proton recoil tracks, show well-defined groups which correspond to excited states in Fe^{55} at 0·42, 0·94, 1·36 and 2·08 MeV. The group corresponding to the level at 1·36 MeV has an unusually large width indicating that this level is complex. The Q-value for the ground-state reaction was measured to be $-1{\cdot}05 \pm 0{\cdot}05$ MeV, giving the threshold for neutron production as $1{\cdot}07 \pm 0{\cdot}05$ MeV. Levels in Fe^{55} at 0·935 and 1·41 MeV have been found by Deutsch and Hedgran from a study of the decay scheme of Co^{55}. These levels correspond closely to two of the levels reported here. A.

539.172.13 : 537.534.74

The scattering of protons by tritons. *See Abstr.* 5481

539.172.13

5754. Neutron-gamma-ray angular correlation in the disintegration of Li^7 by deuterons. J. THIRION AND T. MULLER. *C.R. Acad. Sci., Paris*, **232**, 1093–4 (*March* 12, 1951). *In French.*

A correlation of the form $1{-}0{\cdot}45\cos^2\theta$ was observed at a bombarding voltage of 720 keV. B. ROSE

539.172.13

5755. Angular distribution of fast neutrons from deuteron bombardment (of Be). K.-H. SUN, D. HARRIS, F. A. PECJAK, B. JENNINGS, A. J. ALLEN AND J. F. NECHAJ. Letter in *Phys. Rev.*, **82**, 266 (*April* 15, 1951).

This was measured using detectors with neutron thresholds at 0·95, 2·4, 7·7 and 10·8 MeV. In the last case a peak of 15° was found, probably associated with a neutron stripping process [S. T. Butler, Abstr. 3016 (1951)]. W. J. SWIATECKI

539.172.13

5756. Note on total yield of alphas from $Li^6(d,\alpha)\alpha$. R. RESNICK. Letter in *Phys. Rev.*, **82**, 447 (*May* 1, 1951).

It is pointed out that it is difficult to get theoretical agreement with experimental results below 4 MeV without the assumption of a second state around 4 MeV. Extension of the energy range of the experiments is desirable. J. H. FREMLIN

539.172.13

5757. Angular yield of protons, tritons, and alphas from the deuteron bombardment of beryllium. I. RESNICK AND S. S. HANNA. *Phys. Rev.*, **82**, 463–7 (*May* 15, 1951).

The photographic target chamber incorporating limited magnetic deflection of product particles, which was used to investigate the Be plus proton reactions, has been applied to the Be plus deuteron reactions. Angular yields of the long and the short range protons, the tritons and the unresolved alphas were obtained at bombarding energies below 1 MeV. Most of the distributions are fairly complex and energy dependent. The 90° yield of the long range protons increases rapidly with energy up to 900 keV, except for an anomaly at 700 keV. Tritons having a continuous distribution in energy, resulting from the 3-particle disintegration $Be^9(d,t)2\alpha$, were observed. Range measurements on the mono-energetic triton group give a $Q = 4{\cdot}61 \pm 0{\cdot}04$ MeV for the $Be^9(d,t)Be^8$ reaction. A.

539.172.13

5758. The angular distribution of the products of the $T(d,n)He^4$ reaction. J. E. BROLLEY, JR., J. L. FOWLER AND E. J. STOVALL, JR. *Phys. Rev.*, **82**, 502–5 (*May* 15, 1951).

The differential cross-section of the reaction $T(d,n)He^4$ for 10·5 MeV deuterons has been measured from 180° to 33° centre-of-mass angle of the alpha-particle. Both neutrons and alpha-particles were counted. The angular distribution is similar to that of the mirror reaction, $He^3(d,p)He^4$. A.

539.172.13

5759. The T + T reactions. K. W. ALLEN, E. ALMQVIST, J. T. DEWAN, T. P. PEPPER AND J. H. SANDERS. Letter in *Phys. Rev.*, **82**, 262 (*April* 15, 1951).

The measured energy distributions of α-particles and neutrons from these reactions show no evidence for a di-neutron (n^2). W. J. SWIATECKI

539.172.3

5760. The reaction $^6Li(\gamma n)^5Li$ and energy levels of the ^5Li nucleus. E. W. TITTERTON AND T. A. BRINKLEY. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 212–14 (*Feb.*, 1951).

The analysis of 70 V-shaped tracks in Ilford E_1

emulsions loaded with the isotope Li^6 and irradiated with γ-rays from the 440 keV $Li^7 p\gamma$ resonance, which are interpreted as the break-up of the Li^5 nucleus according to: $Li^6 + h\nu = n^1 + Li^5 - Q_1$; $Li^5 = H^1 + He^4 + Q_2$, gave a value $Q_2 = 1{\cdot}6 \pm 0{\cdot}2$ MeV for the instability of the ground state of Li^5 and $2{\cdot}5 \pm 0{\cdot}5$ for a possible excited state. The cross-section for the reaction $Li^6(\gamma, n)$ is estimated at $(5 \pm 2) \times 10^{-28}$ cm^2. W. J. SWIATECKI

539.172.3

5761. Gamma-alpha-reaction in Rb^{87}. R. N. H. HASLAM AND H. M. SKARSGARD. Letter in *Phys. Rev.*, **81**, 479–80 (*Feb.* 1, 1951).

The activation curve in the energy range 15–27·4 MeV, was studied by observing the Br^{83} activity in $RbNO_3$ irradiated by γ-rays from a betatron. The cross-section as a function of energy was deduced, and discussed together with the reaction threshold. J. HUGHES

539.172.3

5762. Photo-nuclear stars in emulsions. R. D. MILLER. Letter in *Phys. Rev.*, **82**, 260 (*April* 15, 1951).

C2 plates were exposed directly to the X-ray beam of the Berkeley electron synchrotron. Counting stars of 3 or more prongs, the cross-section for star production in Ag is $8 \cdot 10^{-27}$ cm^2 at about 300 MeV.

E. P. GEORGE

539.172.3

5763. The angular distribution of photo-protons from deuterium. G. GOLDHABER. *Phys. Rev.*, **81**, 930–5 (*March* 15, 1951).

The angular distribution of the photo-protons from the photo-disintegration of deuterium was measured. The 6 and 7 MeV gamma-rays from the $F^{19} + H^1$ reaction were used as a gamma-ray source. Photographic emulsions loaded with deuterium were used to record the photo-proton tracks. The angular distribution is best fitted by the expression $a + b \sin^2\theta(1 + \kappa \cos\theta)$ with values of a/b of $0{\cdot}09 \pm 0{\cdot}07$, $0{\cdot}17 \pm 0{\cdot}07$, $0{\cdot}15 \pm 0{\cdot}06$ for $E_\gamma = 6$, 7 and 6 and 7 MeV combined, respectively. For 6 and 7 MeV combined, $\kappa = 0{\cdot}4(+0{\cdot}2, -0{\cdot}3)$. Using the 6 MeV gamma-ray line as a calibration point, a value $E_\gamma = 7{\cdot}1 \pm 0{\cdot}1$ was obtained for the 7 MeV line. A.

539.172.3

5764. Photo-activation of bismuth. N. SUGARMAN AND R. PETERS. *Phys. Rev.*, **81**, 951–2 (*March* 15, 1951).

Work is reported on non-fission activities produced in Bi under irradiation with photons of 48 and 86 MeV maximum energies. The results are similar to those obtained by bombardment with high energy particles in that many particles are emitted. A.

539.172.3

5765. High-energy photo-nuclear reactions. K. STRAUCH. *Phys. Rev.*, **81**, 973–81 (*March* 15, 1951).

Transition curves in Pb of the photons responsible for various nuclear reactions have been obtained using 322 MeV bremsstrahlung from a synchrotron. The area under these curves or "track length" determines an effective photon energy. The integrated cross-sections of the reactions $C^{12}(\gamma, n)C^{11}$ and $Cu^{63}(\gamma, n)Cu^{62}$ are found to be 0·090 and 0·76 MeV-barn, respectively. Relative yields of various reactions from Zn have been measured, and relative cross-sections have been calculated from these and the effective photon energies. A lower limit of 1·4 MeV-barns is obtained for the total cross-section for photon absorption by the Zn nucleus, and 30 MeV is found for a lower limit to the average photon energy absorbed by the same nucleus. These results are discussed with respect to the proposed theories for nuclear photon absorption. A.

539.172.3

5766. Effective photon energies of high energy photo-nuclear reactions. L. EYGES. *Phys. Rev.*, **81**, 981–7 (*March* 15, 1951).

An attempt has been made to use shower theory to evaluate the effective energies of the photo-nuclear reactions measured by Strauch [preceding Abstr.]. It seems that these energies can be determined most accurately from the area under the transition curve, the so-called "track length." A theoretical formula for the track length is discussed. The shape of the transition curve at small thicknesses can also be calculated quite accurately and serves as a rough check on the effective energies as derived from the track length. A comparison with experiment of the theoretical shape of the whole transition curve is given; and, as one would expect, the agreement is not very good. A.

539.172.3

5767. Photo-mesons from carbon. J. M. PETERSON, W. S. GILBERT AND R. S. WHITE. *Phys. Rev.*, **81**, 1003–11 (*March* 15, 1951).

Photons from the Berkeley 322 MeV electron synchrotron have been used to produce mesons from a C target. These mesons have been observed with nuclear emulsions at angles of 45°, 90° and 135° to the photon beam. The ratio of the number of π^- to π^+ mesons produced is $1{\cdot}29 \pm 0{\cdot}22$, $1{\cdot}30 \pm 0{\cdot}12$ and $1{\cdot}34 \pm 0{\cdot}20$, respectively, at each of the above angles. The energy spectra and the differential cross-sections of π-mesons at each of these angles have been obtained. The total cross-section for the production of π-mesons is $4{\cdot}0 \pm 1{\cdot}6 \times 10^{-28}$ cm^2 per nucleus per "equivalent quantum." The number of "equivalent quanta," Q, is defined as the total energy in the beam divided by the maximum photon energy. The cross-section for production of μ-meson pairs at the target is estimated to be $< 2\%$ of the cross-section for π-meson production. A.

539.172.3

5768. The mechanism of star production by gamma-rays. S. KIKUCHI. Letter in *Phys. Rev.*, **81**, 1060 (*March* 15, 1951).

Nuclear emulsions were exposed directly to the γ-ray beam of the Cornell synchrotron, the beam being monitored by the activity produced in a C plate. The cross-section averaged over all emulsion atoms at 300 MeV is 6×10^{-27} cm^2. E. P. GEORGE

539.172.3

5769. Cross section for the reaction $C^{12}(\gamma, n)C^{11}$. R. N. H. HASLAM, H. E. JOHNS AND R. J. HORSLEY. Letter in *Phys. Rev.*, **82**, 270 (*April* 15, 1951).

The activation curve for the reaction was obtained by counting the C^{11} activity produced by γ-rays from

a betatron. The cross-section, deduced from the activation curve, has a peak value of 11·6 millibarns at 22·4 ± 0·5 MeV. The width at half maximum is 4·25 MeV, and the integrated cross-section 0·047 MeV-barn. A self-absorption curve for the C^{11} positrons is given. J. HUGHES

539.172.3

5770. Photoneutron cross sections of Fe^{54}, Ni^{58} and Zn^{64}. L. KATZ, H. E. JOHNS, R. G. BAKER, R. N. H. HASLAM AND R. A. DOUGLAS. Letter in *Phys. Rev.*, **82**, 271 (*April* 15, 1951).

These were measured by a method previously described [Abstr. 3021 (1951)]. The maximum cross-sections are, Fe^{54} 0·067 ± 0·006 barn, Ni^{58} 0·060 ± 0·006 barn, and Zn^{64} 0·12 ± 0·01 barn, all at an energy of approximately 18·5 MeV. A summary of photoneutron cross-section data is given. J. HUGHES

539.172.3

5771. Interpretation of photoneutron yields. A. G. W. CAMERON. Letter in *Phys. Rev.*, **82**, 272 (*April* 15, 1951).

Recent data [Abstr. 5277 (1950) and preceding Abstr.] are compared with theoretical predictions. B. ROSE

539.172.3

5772. Absorption of 280-Mev photons. J. W. DEWIRE, A. ASHKIN AND L. A. BEACH. Letter in *Phys. Rev.*, **82**, 447 (*May* 1, 1951).

Total cross-sections in Be, Al, Cu, Sn, Pb and U were measured.

539.172.3

5773. Photonuclear effects in carbon from 100 MeV betatron X-rays. E. R. GAERTTNER AND M. L. YEATER. Letter in *Phys. Rev.*, **82**, 461 (*May* 1, 1951)

Describes results of 1 800 disintegrations observed in a methane-filled cloud-chamber exposed to the X-ray beam. E. P. GEORGE

539.172.3

5774. Photo-production of N^{17}. W. E. STEPHENS, J. HALPERN AND R. SHER. *Phys. Rev.*, **82**, 511–14 (*May* 15, 1951).

The delayed neutron activity associated with N^{17} has been produced by the X-ray irradiation of O, the reaction being identified as $O^{18}(\gamma, p)N^{17}$. The threshold for this transmutation has been observed as 16·35 ± 0·2 MeV, and the integrated cross-section calculated to be 0·15 ± 0·1 MeV-barn. The N^{17} produced was identified by measuring the neutron activity half-life as 4·15 ± 0·1 sec. A.

539.172.3

5775. The photodisintegration of the deuteron. W. M. GIBSON, T. GROTDAL, J. J. ORLIN AND B. TRUMPY. *Phil. Mag.*, **42**, 555–65 (*May*, 1951).

This has been observed in photographic plates exposed, while wet with heavy water, to the γ-rays arising from the bombardment of fluorine with ·4 MeV protons. Two groups of protons, produced by the known γ-ray lines at 6·15 MeV and 7·01 MeV, have been clearly resolved. It is shown that γ-ray energies of this order of magnitude can be measured with a probable error of 0·05 MeV, and γ-ray lines with an energy difference of 0·6 MeV can be resolved. Suggestions are made for a further improvement of the technique which should increase the resolving power of the method. The angular distribution of the protons produced by each of the two γ-ray lines has been measured, but statistical uncertainties must be further reduced before any useful comparison with theory can be made. A.

539.172.3

5776. Direct photodisintegration processes in nuclei. E. D. COURANT. *Phys. Rev.*, **82**, 703–9 (*June* 1, 1951).

The unexpectedly large (γ, p) cross-sections found in many moderately heavy nuclei are interpreted in terms of a direct photodisintegration process. The gamma-ray quantum is supposed to be absorbed by one proton in the nucleus, which is then emitted without the formation of an intermediate compound nucleus. The cross-section for this process is small compared with that for the formation of a compound nucleus (which would almost always lead to the eventual emission of a neutron), but it has to be only a few millibarns to account for the experimental results. It is shown that if the nucleus is represented by a square well potential, the calculated cross-sections turn out to be smaller than the experimental ones, but much larger than those obtained from the statistical theory. The angular distribution of the emitted protons should be of the form $A + B\sin^2\theta$, where θ is the angle between the incoming photon and the proton, and the ratio B/A depends on the angular momentum of the proton in the nucleus. This is confirmed by experimental results; from the experimental values of B/A it appears that protons with $l = 0$ in the nucleus contribute considerably to the effect in Rh and Ag. Feenberg's "wine bottle" potential can account for this more easily than the square well. The theory is applicable to fast photoneutron emission as well, and recent experiments by Poss show that fast photoneutrons are indeed emitted anisotropically. It is suggested that similar direct interaction mechanisms may account for the deviations of (n, p) cross-sections from those predicted by the theory, as found recently by Wäffler. A.

539.172.3

5777. Photoprotons from magnesium. M. E. TOMS AND W. E. STEPHENS. *Phys. Rev.*, **82**, 709–14 (*June* 1, 1951).

The distributions in energy and in angle of the protons ejected from Mg by the bremsstrahlung X-rays of a 24 MeV betatron have been observed in nuclear emulsions. Both normal Mg and enriched Mg^{25} show a uniform angular distribution for all proton energies. The energy distribution of the protons from enriched Mg^{25} is compared to the distributions calculated from an evaporation process using various energy level densities. Good agreement is obtained using the known Na^{24} level densities. The integrated cross-section of the $Mg^{25}(\gamma, p)$ reaction is determined as 0·056 ± 0·03 MeV-barn. A.

539.172.3

5778. Yields of photoprotons from twenty elements. A. K. MANN AND J. HALPERN. *Phys. Rev.*, **82**, 733–8 (*June* 1, 1951).

Scintillation counters have been applied to the study of the yields of photoprotons from twenty elements.

The relative yields increase by a factor of approximately one hundred as Z increases from 4 to 28, and then decrease to a value, at $Z = 50$, of about one-tenth that of the maximum at $Z = 28$. An upper limit is placed on the yields from several heavy elements. The absolute values are compared with the neutron data of Price and Kerst, and the sum of the two yields is compared with theory. A.

539.172.3 : 539.163.1

5779. The nuclear excitation of Ag^{107} and Ag^{109} by X-rays. E. J. Wolicki, B. Waldman and W. C. Miller. *Phys. Rev.*, **82,** 486–8 (*May* 15, 1951).

X-rays, produced by monoergic electrons, were used to excite the separated isotopes of Ag to their metastable states. The half-life of Ag^{107} was $44{\cdot}0 \pm 1{\cdot}0$ sec, of Ag^{109*} $40{\cdot}0 \pm 1{\cdot}0$ sec. These measurements agree with those of Bradt, *et al.*, and the isotopic assignment of Helmholz. The electron energy was varied between 0·8 MeV and 2·3 MeV to obtain the excitation curves. The thresholds for X-ray excitation of both Ag^{107} and Ag^{109} were below 0·8 MeV. An activation level in Ag^{107} was found at $1{\cdot}285 \pm 0{\cdot}018$ MeV. An activation level in Ag^{109} was found at $1{\cdot}210 \pm 0{\cdot}018$ MeV. The over-all cross-section (i.e. per incident electron on thick Au target) is of the order of 10^{-34} cm^2 for both isotopes at 1·4 MeV. A.

539.172.4

5780. Neutron cross-section and nuclear shell structure. S. Yamabe and J. Sanada. Letter in *Progr. Theor. Phys.*, **5,** 1049–50 (*Nov.–Dec.*, 1950).

Results on inelastic scattering of H. Aoki [*Proc. Phys. Math. Soc. Japan*, **19,** 370 (1937); Nonaka, *ibid.*, **25,** 227 (1943); S. Kikuchi, H. Aoaki, *ibid.*, **21,** 75 (1939)] are plotted and positions of closed shells indicated. W. J. Swiatecki

539.172.4

5781. The range in minerals of tritons from the reaction $Li^6(n, \alpha)$ H^3 (2·7 MeV). P. Janssens. *C.R. Acad. Sci., Paris,* **232,** 825–7 (*Feb.* 26, 1951) *In French.*

The range in microns of tritons of energy 2·7 MeV has been calculated for an arbitrary medium by integrating Bethe's formula, and the results are exhibited in graphical and tabular form (for several lithium-bearing minerals). The accuracy is about 10%. A. O. Stanesby

539.172.4 : 539.152.1

5782. Neutron capture cross sections and level density. H. Hurwitz, Jr. and H. A. Bethe. Letter in *Phys. Rev.*, **81,** 898 (*March* 1, 1951).

The fluctuation of these quantities from isotope to isotope, and the relation to the neutron and proton numbers is discussed. To correlate these fluctuations, it is suggested that the significant quantity in determining level densities is the excitation energy measured from a characteristic level which depends in a smooth way on the number of protons and neutrons in the nucleus. J. Hughes

539.172.4

5783. Variation with energy of nuclear collision cross sections for high energy neutrons. J. DeJuren and B. J. Moyer. *Phys. Rev.*, **81,** 919–23 (*March* 15, 1951).

Nuclear total cross-sections for high energy neutrons have been measured, mainly of C, Al, Cu and Pb, for approximately known neutron energies in the range 90 to 270 MeV. It is observed that cross-sections in every case drop rather rapidly between 100 and 180 MeV to a level which continues with little further variation up to the highest neutron energies available in the experiment. Comparisons are made with nuclear attentuation data for cosmic rays. A.

539.172.4

5784. An interpretation of nuclear cross sections for high energy neutrons. R. Jastrow. Letter in *Phys. Rev.*, **82,** 261 (*April* 15, 1951).

Uses an optical model describing nuclear matter by an index of refraction and an absorption coefficient. Better results are obtained with a strong central repulsion surrounded by an attractive well [see also Abstr. 3331 (1951)]. A. O. Stanesby

539.172.4

5785. The total cross section of beryllium, aluminium, sulphur and lead for neutrons of energies from 2 MeV to 6 MeV. G. H. Stafford. *Proc. Phys. Soc., Lond. A,* **64,** 388–95 (*April*, 1951).

The cross-sections have been measured from 2 to 4 MeV and from 5 to 6 MeV by a transmission experiment. Resonances were observed in all four elements. The results obtained for Pb and for Be are compared with those expected according to the one-body theory for light nuclei. A.

539.172.4

5786. The hydrogen and carbon total cross-sections for neutron energies between 39 MeV and 156 MeV. A. E. Taylor, T. G. Pickavance, J. M. Cassels and T. C. Randle. *Phil. Mag.*, **42,** 328–30 (*April*, 1951).

The cross-sections were measured at neutron energies of 39, 64·5 and 97 MeV, using a recoil proton telescope as a neutron detector. At these three energies the H cross-sections are $223 \pm 7{\cdot}6$, 126 ± 3 and $73{\cdot}9 \pm 3{\cdot}0 \times 10^{-27}$ cm^2 respectively. The corresponding C cross-sections are $1\,100 \pm 20$, 784 ± 5 and $508 \pm 5 \times 10^{-27}$ cm^2. A.

539.172.4

5787. Polarization effects in $(n - \gamma)$ reactions. O. Halpern. Letter in *Phys. Rev.*, **82,** 753 (*June* 1, 1951).

Briefly discusses the possible observable effects of a reaction utilizing a polarized neutron beam.

539.172.4 : 539.185.7

5788. Total cross section of helium for fast neutrons. S. Bashkin, F. P. Mooring and B. Petree. *Phys. Rev.*, **82,** 378–80 (*May* 1, 1951).

The cross-section has been determined at energies from 40 keV to 4·9 MeV by comparison of the transmission of neutrons through a He-filled cylinder with the transmission through an identical empty cylinder. The observed cross-section increases smoothly from 0·8 barn at 40 keV to 6·7 barns at 1·15 MeV, and then decreases smoothly to 2·3 barns at 4·9 MeV. No splitting of the peak at 1·15 MeV was observed. A.

539.172.4

5789. The emission of short-range charged particles in the slow neutron fission of uranium. K. W. ALLEN AND J. T. DEWAN. *Phys. Rev.*, **82**, 527–30 (*May* 15, 1951).

A coincidence counting method has been employed to investigate short-range charged particles produced in the slow neutron fission of U^{235} and U^{233}. In the case of U^{235}, charged particles with ranges up to 8 mm of air were observed with a frequency of one in 76 ± 8 fissions. The maximum initial specific ionization of these particles was 10 times that of α-particles from U, which suggests that some of the particles have masses considerably greater than that of the α-particle. The mass distribution could not be determined from the experimental data. Additional experiments proved that the observed particles were not nuclear recoils produced by fission fragments in their passage through the source and counter gas or fission fragments scattered by the backing material of the source. In the fission of U^{233}, particles were observed with ranges up to 7·4 mm of air with an abundance of one in 72 ± 6 fissions. A.

539.172.4

5790. Meson production accompanying uranium fission. H. BRADNER AND J. K. BOWKER. Letter in *Phys. Rev.*, **82**, 265 (*April* 15, 1951).

No confirmation of the single existing photograph of this process was found in bombardments of U by (*a*) slow neutrons, (*b*) π^- mesons. W. J. SWIATECKI

539.172.4

5791. The mode of operation of the uranium reactor. R. LILJEBLAD. *Ark. Fys.*, **3**, *Paper* 3, 41–6 (1951).

A revision of an earlier paper [Abstr. 6069 (1950)] in the light of more precise data on U fission, recently declassified. L. R. SHEPHERD

539.172.4 : 620.9

5792. Economic aspects of atomic power. *Princeton University Press, London, Geoffrey Cumberlege* (1950) 289 *pp.*

A study prepared by the Cowles Commission for Research in Economics, Chicago University, under the direction of S. H. Schurr and J. Marschak. Part I makes a comparison of the costs of power generation as between atomic power and conventional energy sources. Part II examines in some detail the importance of energy in some particular industries, and the possible ways in which they might be affected by the development of commercial atomic power. Part III attempts to assess the character and magnitude of the direct and indirect cumulative effects (economic, social, geographical, etc.) that may be initiated by the availability of cheap atomic power. 32 tables, 4 maps, 2 graphs.

ATOM AND MOLECULE BEAMS . MESONS . NEUTRONS 539.18

539.18

5793. Radiative disintegration of scalar mesons. M. S. GOBEDZHISHCHBILI. *J. Exp. Theor. Phys.*, **20**, 893–7 (*Oct.*, 1950) *In Russian.*

Calculates the probability of decay into electron, neutrino and photon. For small photon energies, the probability diverges logarithmically. E. P. GEORGE

539.18

5794. Production of scalar and pseudoscalar mesons by photons. G. ARAKI. *Progr. Theor. Phys.*, **5**, 507–18 (*July–Aug.*, 1950).

The cross-sections, σ, are calculated using the customary perturbation method. Numerical values are given in graphs extending to 2×10^{11} eV. All theories predict the ratio σ^-/σ^+ increases markedly with energy, reaching approx. 10 at 10^{11} eV.

E. P. GEORGE

539.18

5795. On the scattering of π-mesons by nucleons. J. ASHKIN, A. SIMON AND R. MARSHAK. *Progr. Theor. Phys.*, **5**, 634–68 (*July–Aug.*, 1950).

The cross-sections, σ, are calculated in some detail for meson energies 1, 3 and $10 \times mc^2$, using Feynman's diagrams. *S* and *PS* mesons only are considered, with all possible nucleon couplings. The S(*S*) and *PS*(*PS*) σ's are much smaller than experimental values at $E \sim 3\,mc^2$, while the *S*(*V*) and *PS*(*PV*) cross-sections are too big. The latter values are not yet above suspicion as the method still gives divergences here. It is suggested that the *S*(*S*) and *PS*(*PS*) theories may be discarded. The remaining theories predict rapid increase of σ with energy in region 1 to $6\,mc^2$ and experimental investigation in this region would be of great value. E. P. GEORGE

539.18

5796. On the decay of a heavy Dirac meson. H. FUKUDA AND S. HAYAKAWA. *Progr. Theor. Phys.*, **5**, 993–6 (*Nov.–Dec.*, 1950).

The life-time of the τ-meson ($\tau \rightarrow \pi + \mu$ or neutrino) was calculated for various types of π and coupling. Using regulators to remove the infinities the results vary between 10^{-8} and 10^{-13} sec.

W. J. SWIATECKI

539.18

5797. Photo-meson production and nucleon isobar. Y. FUJIMOTO AND H. MIYAZAWA. Letter in *Progr. Theor. Phys.*, **5**, 1052–4 (*Nov.–Dec.*, 1950).

Agreement with the experimental cross-section and angular distribution of the γ–π process [Abstr. 7502 (1950); 2060 (1951)] is improved if an excited state of the proton is assumed in the calculations.

W. J. SWIATECKI

539.18

5798. On the coupling schemes for mesons. W. THIRRING. Note in *Z. Naturforsch.*, **6a**, 53–4 (*Jan.*, 1951) *In German.*

Discusses possible coupling schemes in the light of decay evidence. E. P. GEORGE

539.18

5799. On the decay of μ-mesons. V. VOTRUBA AND Č. MUZIKÁŘ. Letter in *Phys. Rev.*, **82**, 99 (*April* 1, 1951).

Discusses the relative probabilities of non-standard decay schemes. E. P. GEORGE

539.18

5800. Production of π-mesons in nucleon-nucleon collisions. K. BRUECKNER. *Phys. Rev.*, **82**, 598–606 (*June* 1, 1951).

The production of π-mesons in nucleon-nucleon collisions as predicted by scalar meson theory,

pseudo-scalar meson theory with pseudoscalar and pseudovector coupling, and vector theory with vector coupling is compared with experimental results. The calculations are made on the basis of 3rd-order perturbation theory using the methods of Feynman and Dyson and also using a phenomenological treatment of the nucleon-nucleon interaction. Account is taken of the fact that the final nucleons are not in plane wave states. It is shown that pseudoscalar theory with pseudovector coupling gives qualitative agreement with experiment. A.

539.18 : 530.145

The production of mesons in proton-proton collisions. *See Abstr.* 5126.

539.181

5801. On the focusing of a molecular beam by a non-uniform magnetic field. M. I. KORSUNSKIĬ AND YA. M. FOGEL. *J. Exp. Theor. Phys.*, **21**, 25–37 (*Jan.*, 1951) *In Russian.*

Three examples are considered of focusing of particles of mass m having a magnetic moment μ always anti-parallel to the field and independent of its magnitude. (1) The field is symmetric about the z-axis and about a plane normal to the z-axis. In the median plane the field is $H_z = H_0 + \frac{1}{2}a(x^2 + y^2)$ where a is a constant. Gravity acts in the $-y$ direction. A point source at $x = 0$, $y = y_0$ is perfectly focused at $x = 0$, $y = -y_0 - 2\,\mathrm{mg}/\mu a$ for all angles and speeds of emission. Only rays confined to the median plane are considered. (2) The field is not a function of z; $H_x = axy$, $H_y = \frac{1}{2}a(x^2 - y^2)$. Gravity acts in the $-y$ direction. x and y are the same functions of time as in case (1), save that the velocity component $\perp$ z-axis plays the role of velocity in the median plane. $\dot{z} = 0$ so that particles of given μ/m are focused to a line, parallel to the z-axis, having $\dot{z}$ as parameter. In both (1) and (2) practical limitations of extent and intensity of field restrict focusing to slow molecules, so that a detector of high sensitivity would be needed. (3) A field as in (2) but of finite z-extent acts like a lens, with object and image on the z-axis outside the field. The paraxial image position is calculated neglecting fringing field and gravity. For given geometry, the position of the focus depends only on $v(m/\mu a)^{\frac{1}{2}}$, where v is the speed of the particles. J. C. E. JENNINGS

539.181

5802. On the motion of particles with magnetic moment in an exponential magnetic field. YA. M. FOGEL. *J. Exp. Theor. Phys.*, **21**, 38–41 (*Jan.*, 1951) *In Russian.*

Similar considerations to those of preceding Abstr. for a field $H_x = H_0 e^{bx} \sin by$; $H_y = H_0 e^{bx} \cos by$ independent of z. Gravity acts in $+y$ direction. Source is at origin; $\dot{z}_0 = v$; rays make a small angle with z-axis. At given x, the y displacement $\propto mg/\mu b^2 H_0$ whilst the z displacement $\propto v(m/\mu b^2 H_0)^{\frac{1}{2}}$. Thus there is a "focal line" parallel to the z-axis and there is μ/m dispersion; but the gathering power is found to be excessively weak. J. C. E. JENNINGS

539.181.2

5803. A high intensity source for the molecular beam. I. Theoretical. A. KANTROWITZ AND J. GREY. *Rev. Sci. Instrum.*, **22**, 328–32 (*May*, 1951).

Proposes that the first slit be placed in the flow from a miniature high-velocity nozzle coaxial wit the final beam. The nozzle converts part (~ ¾ for Mach number of 4 in the design for air to be pr sented) of the random translational and intern energy of the oven gas into directed mass motio The mass motion provides an initial rough collima tion, which improves both the effusion rate and th geometrical factors, indicating a considerable possib beam intensification (by a factor of ~ 75 in th sample design). The velocities of the molecules i the final beam are grouped about the initial ma velocity which provides a partial velocity selectio A theoretical design study and estimates of pe formance of this type of source are given.

539.181

5804. A high-intensity source for the molecula beam. II. Experimental. G. B. KISTIAKOWSKY AN W. P. SLICHTER. *Rev. Sci. Instrum.*, **22**, 333–7 (*Ma* 1951).

Using NH_3 as a test gas, it was observed that a inlet pressures above about 170 mm the molecula beam intensity began to rise far more rapidly tha the pressure. The maximum observed intensit exceeded by more than a factor of 20 that obtainab from the effusion slits under optimum condition and continued to rise rapidly at the highest inle pressures possible with the available equipmen Certain imperfections of the present apparatu restricted observations to NH_3; their presence ind cates that still greater enhancement of molecula beam intensity is possible with an apparatus of refine design. A

539.18

5805. The primary spectrum of fast neutrons from Ra–Be source and their inelastic collisions in Pb. II H. G. HOUTERMANS AND M. TEUCHER. *Z. Phys.*, **12** (*No.* 3) 365–8 (1951) *In German.*

Abstr. 1241 (1950), part I. The spectrum of th neutrons from a Ra–Be source, slowed by 7 cm Pb was obtained by examining knock-on protons in nuclear emulsion, and compared with that of th primary neutrons. It is concluded that neutron must lose large amounts of energy in single inelasti collisions. A. O. STANESB

539.185 : 539.152.

5806. Scattering of neutrons by ferromagneti crystals. R. G. MOORHOUSE. Letter in *Proc. Phys Soc., Lond. A*, **64**, 207–8 (*Feb.*, 1951).

Suggests an experimental test of the Bloch mode by observing the scattering by Fe of neutrons wit wavelengths too great for Bragg scattering. At tem peratures not too far below the Curie point the F should lose energy to the neutrons owing to th re-orientation of disoriented electron spins. Th differential cross-section for the effect is estimated t be about 8 barn. J. THEWLI

539.185 : 539.172.4 : 545.

5807. Autoradiography by neutrons. Separat dosage from U and Th in minerals. I. CURIE AN H. FARAGGI. *C.R. Acad. Sci., Paris*, **232**, 959–6 (*March* 5, 1951) *In French.*

Describes a technique for the quantitative deter mination of U and Th in rocks. It is based on th fact that thermal neutrons produce fission in U bu

not in Th, and consists essentially in bombarding the sample by thermal neutrons in a pile, while held in contact with a nuclear emulsion. The effects of fission fragments are measured; and from the estimated percentage of U and the total α-activity the amount of Th is found by difference. Precautions are taken against (n, α) reactions arising from impurities and against γ-ray fogging. The smallest amount of U at present detectable is 10^{-4} g/g, with an accuracy of about 6%. J. THEWLIS

539.185 : 548.74

5808. Effect of short wavelength interference on neutron scattering by dense systems of heavy nuclei. G. PLACZEK, B. R. A. NIJBOER AND L. VAN HOVE. *Phys. Rev.*, **82**, 392–403 (*May* 1, 1951).

The interference term in the expression for the total cross-section for scattering of neutrons by dense systems of heavy nuclei is investigated in the region of small wavelength. Asymptotically, this term has the form $\delta\sigma/\sigma = -(\lambda^2\rho^{\frac{2}{3}}/8\pi)I$, where λ is the neutron wavelength and ρ the number of particles per unit volume. The discussion of the coefficient, I, and its evaluation for various systems is the main object of the paper. It is based on an extension to general systems of particles of Ewald's method for the calculation of lattice sums. For any system, I is found to be < 3. It remains very near to this value for all systems not too far removed from conditions of close packing. The cases of ideal lattices, real crystals with thermal disorder, and liquids are treated in detail. A.

539.185.08 : 537.542

5809. The $^{12}C(n, 2n)^{11}C$ reaction in an anthracene crystal. J. SHARPE AND G. H. STAFFORD. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 211–12 (*Feb.*, 1951).

This was used as the basis of a sensitive neutron detector (down to a flux of 15 neutrons $cm^{-2}\ sec^{-1}$). The positrons from the decaying C^{11} produce scintillations in the crystal itself which are counted with an E.M.I. photomultiplier tube. A Fermi plot for the positrons illustrates the possibility of using this technique for β-spectroscopy. W. J. SWIATECKI

STRUCTURE OF SOLIDS 539.2

539.21 : 541.135

5810. The structure of electrodeposited metals. A. W. HOTHERSALL. *J. Electrodepos. Tech. Soc.*, **25**, 203–10 (1950).

A short account of some of the factors affecting the structure of electrodeposited metals, with reference to the interference theory of crystal growth and the influence of the base metal structure and surface.

A. E. DE BARR

539.21 : 536.7

5811. Thermodynamic investigations on ternary amalgams. C. WAGNER. *J. Chem. Phys.*, **19**, 626–31 (*May*, 1951).

Under certain conditions, interaction between positively charged metal ions in an alloy may be considered as less important than interaction between conduction electrons and metal ions. Then it follows that the activity of a solute metal 2 dissolved in metal 1 will be increased by a third component if metals 2 and 3 change the valence electron/atom ratio in the same direction. Conversely, the activity of a solute metal 2 will be decreased by a third component if metals 2 and 3 change the valence electron/atom ratio in opposite directions. In addition, an equation is derived with the aid of which one may calculate the change in the activity of metal 2 dissolved in metal 1 due to the addition of a solute metal 3 if the changes in the activity coefficients with composition for the binary systems 1–2 and 1–3 are known and interaction between positively charged metal ions can be disregarded. A.

539.211 : 539.89

5812. Some quantitative data bearing on the scabbing of metals under explosive attack. J. S. RINEHART. *J. Appl. Phys.*, **22**, 555–60 (*May*, 1951).

The phenomenon has been investigated for 5 metals, 1 020 steel, 4 130 steel, 24*S*–*T*4 Al alloy, brass and Cu, by using an explosive charge to induce a high intensity stress wave in the metal. The distribution of pressure within the wave was determined by a modified Hopkinson-bar type of experiment. Scabbing has been found to be governed principally by the spatial distribution of pressure within the wave and a critical normal fracture stress σ_c that is characteristic of the material and perhaps the state of stress. Numerical values of σ_c were obtained for each of the 5 metals. A.

539.215.2

5813. Grain boundary diffusion in metals. A. D. LE CLAIRE. *Phil. Mag.*, **42**, 468–74 (*May*, 1951).

By an extension of a recent analysis of the problem of grain boundary diffusion in metals, the expression $D'/D = \delta^{-1} = 2(\pi Dt)^{1/2}\cot^2\alpha$ has been derived relating the diffusion coefficients D' and D for grain boundary and for volume diffusion, δ the effective "width" of the grain boundary and α the angle at time t between a line of constant concentration and the grain boundary at the point where it meets the grain boundary. Some remarks are made on the use of the equation and when it is applied to a recent experimental observation on grain boundary diffusion of Cu in Ni, the result is deduced that $D' = 8\ cm^2/day$ at 1 000°C. A discussion follows on some aspects of the relation of other work on grain boundaries to grain boundary diffusion. Evidence is presented, based on models of the grain boundary, which suggests that the activation energies for grain boundary and for volume diffusion may not differ appreciably. A.

539.215.7

5814. Oriented crystals in the rolled plates of alloys. S. YAMAGUCHI. Letter in *J. Appl. Phys.*, **22**, 680–1 (*May*, 1951).

539.217

5815. Lattice and grain boundary self-diffusion in silver. R. E. HOFFMAN AND D. TURNBULL. *J. Appl. Phys.*, **22**, 634–9 (*May*, 1951).

The lattice and grain boundary self-diffusion coefficients of high-purity Ag have been measured over extended temperature ranges. It has been found that the lattice diffusion coefficients are described by the equation, $D_L = 0{\cdot}895 \exp(-49\,500/RT)\ cm^2\ sec^{-1}$

and are independent of the thermal history of the crystals within wide limits. The absolute grain boundary diffusion coefficients fit the equation, $D_B = 0{\cdot}03 \exp(-20\,200/RT)$ cm^2 sec^{-1} and are independent of the grain size of the specimens. A.

539.23

5816. A note on thin nickel foils. S. Bashkin and G. Goldhaber. Note in *Rev. Sci. Instrum.*, **22**, 112–13 (*Feb.*, 1951).

Details are given of the electrodeposition of 1 000 and 500 Å Ni foils on Cu backing. The Cu can be dissolved away with activated chromic acid, but this is not quite successful with 250 Å foils. They are metallic by reflected light, but even the 1 000 Å foils are semi-transparent. The 500 Å foil has a stopping power of 8–10 keV for a 1 MeV proton beam, and may be useful as a counter window. Two photographs of the foils and their mounting are shown. R. A. WEALE

539.234

5817. The deposition of rhodium on Perspex. B. L. Ginsborg and O. S. Heavens. Note in *Rev. Sci. Instrum.*, **22**, 114–15 (*Feb.*, 1951).

Optimum conditions are described for plating Rh on to tungsten spirals, and for evaporating it from them on to a Perspex surface. The resultant film has a thickness of about 1 000 Å. Interference fringes show that the substrate is not distorted in the process. R. A. WEALE

539.234

5818. Evaporated zinc sulfide films. J. L. Rood. *J. Opt. Soc. Amer.*, **41**, 201–2 (*March*, 1951).

A study was made of evaporated ZnS films on glass, including method of preparation, optical properties and ageing effects. The influence of rate of evaporation and pressure during evaporation was noted. Thicknesses and indexes of refraction of the films were determined from measurements of reflected intensity as a function of wavelength. ZnS films are quite soft just after preparation but become harder if aged in a dry atmosphere. A.

539.26

5819. Diffuse X-ray scattering by disordered binary alloys. W. J. Taylor. Letter in *Phys. Rev.*, **82**, 279 (*April* 15, 1951).

A general theoretical treatment of diffuse X-ray scattering by disordered binary alloys leading to an expression for the scattered intensity in terms of short-range order parameters. A. E. DE BARR

539.26/.27

5820. Amorphous germanium. H. Richter and O. Fürst. *Z. Naturforsch.*, **6a**, 38–46 (*Jan.*, 1951) *In German.*

Thin evaporated films of Ge were studied by X-ray and electron diffraction, and shown to be amorphous. A structure is proposed, based on Fourier analysis of the scattering curves. A. R. STOKES

539.27

5821. The crystal structure of metallic electrodeposits. G. I. Finch and D. N. Layton. *J. Electrodepos. Tech. Soc.*, **27**, *Paper* 9, 12 *pp.* (1951).

A survey of electron diffraction work on the structure of electrodeposited layers. Considers the effect of bath conditions on crystal growth, the effect of the substrate structure on that of the electro deposited layer, and includes question of crystal size surface texture, stress and porosity. J. THEWLI

539.2

5822. Electron diffraction studies of etched Au lea films. W. V. Stauder and A. H. Weber. *J. Frankli Inst.*, **251**, 351–8 (*March*, 1951).

Anomalies of two kinds occurred, extra lines an orientation effects. The extra lines, in agreement wit the report of Thomson and Cochrane, were attribute to contamination of the films by some long chain com pound. The orientation effects consisted of a varia tion of the intensities of several of the lines of the A patterns obtained from the intensity of these sam lines as observed in standard patterns of randomly oriented Au. These abnormal intensities evidence the existence of the [100] crystal direction as an axi of orientation perpendicular to the face of the film A second orientation effect, the arcing of some of th lines of the Au patterns, indicated a second axis o orientation parallel to the face of the film, bu insufficient evidence prevented the identification o this axis of orientation. A

539.2

5823. Electron diffraction study of cementite forma tion in iron. II. Effect of the gas mixture CO + H J.-J. Trillat and S. Oketani. *C.R. Acad. Sci., Paris* **232**, 1116–18 (*March* 12, 1951) *In French.*

Abstr. 8269 (1950) part I. The experiments indi cate the formation of a compound Fe_2C, stable belo 400°C, as well as cementite, Fe_3C, and pure α-Fe The chemical reaction is believed to be $3Fe + 2CO \rightleftharpoons Fe_3C + CO_2$, $2Fe_3C + 2CO \rightleftharpoons 3Fe_2C + CO_2$ The hydrogen gas accelerates the reaction in th temperature range of stability. E. P. WOHLFARTH

539.27 : 548.52

Grain growth in a texture, studied by means o electron-emission microscopy. *See Abstr.* 5904

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.32 : 621.317.3

5824. An electronic instrument for the measuremen of the damping capacity of materials. A. D. N Smith. *J. Sci. Instrum.*, **28**, 106–9 (*April*, 1951).

The range of frequencies covered is from abou 50 to 10 kc/s. The principle of operation is that th time taken for the amplitude of vibration to fall t half its value during free decay is measured, by mean of a circuit which transmits two pulses to a standar electronic timing instrument at the appropriat moments. The apparatus may be used to measure th rate of decay of any vibration provided that it is ex ponential and the frequency is in the specified range. A

539.37

5825. Large elastic deformations of isotropi materials. VII. Experiments on the deformation o rubber. R. S. Rivlin and D. W. Saunders. *Philos Trans A*, **243** (*No.* 865) 251–88 (1951).

See Abstr. 2723 (1950) for part VI. It is shown i this part how the theory of large elastic deformation

of incompressible isotropic materials, developed in previous parts, can be used to interpret the load-deformation curves obtained for certain simple types of deformation of vulcanized rubber test-pieces in terms of a single stored-energy function. The types of experiment described are: (i) the pure homogeneous deformation of a thin sheet of rubber in which the deformation is varied in such a manner that one of the invariants of the strain, I_1 or I_2, is maintained constant; (ii) pure shear of a thin sheet of rubber; (iii) simultaneous simple extension and pure shear of a thin sheet; (iv) simple extension of a strip of rubber; (v) simple compression; (vi) simple torsion of a right-circular cylinder; (vii) superposed axial extension and torsion of a right-circular cylindrical rod. It is shown that the load-deformation curves in all these cases can be interpreted on the basis of the theory in terms of a stored-energy function W which is such that $\partial W/\partial I_1$ is independent of I_1 and I_2 and the ratio $(\partial W/\partial I_2)/(\partial W/\partial I_1)$ is independent of I_1 and falls, as I_2 increases, from about 0·25 at $I_2 = 3$. A.

539.371

5826. Large elastic deformations of isotropic materials. VIII. Strain distribution around a hole in a sheet. R. S. RIVLIN AND A. G. THOMAS. *Philos. Trans A*, **243** (*No.* 865) 289–98 (1951).

The deformation produced by radial forces in a thin circular sheet of incompressible highly elastic material, isotropic in its undeformed state, containing a central circular hole, is studied theoretically, and results calculated on the basis of the theory are compared with those obtained experimentally employing a vulcanized natural rubber compound as the highly elastic material. A.

539.373 : 548.7

5827. The equilibrium of linear arrays of dislocations. J. D. ESHELBY, F. C. FRANK AND F. R. N. NABARRO. *Phil. Mag.*, **42,** 351–64 (*April*, 1951).

A method is given for finding the equilibrium positions of a set of like dislocations in a common slip-plane under the influence of a given applied stress. Their positions are given by the roots of a certain set of orthogonal polynomials. The case of a set of free dislocations piled up against a fixed dislocation by a constant applied stress is discussed in detail and the resulting stress-distribution is compared with that produced by a crack with freely slipping surfaces. A.

539.374

5828. Rectilinear flow of non-Bingham plastic solids and non-Newtonian viscous liquids. II. J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 410–18 (1951).

For part I, see Abstr. 1269 (1950). The equation of steady rectilinear motion of a material of variable viscosity is transformed, when the pressure gradient vanishes, into a second-order differential equation which is linear in the dependent variable. A general solution of the linearized equation can be obtained in the case of a wide class of plastic solids and viscous liquids. By making use of the idealized materials which lend themselves to this method of solution, a theoretical comparison can be made of the behaviour of plastic solids of different types under the same conditions. As an illustration, a plastic solid which yields very sharply when the yield point is first exceeded is compared with one which yields only gradually at the same yield value; the flow caused by the longitudinal motion of an (approximately) elliptic cylinder in an infinite mass of material is investigated in each case. A.

539.374

5829. Foundations of the mathematical theory of plasticity—and experiment. P. P. BIJLAARD. *Z. angew. Math. Phys.*, **2** (*No.* 2) 114–17 (1951) *In German.*

It is shown that Stüssi's experimental results [Abstr. 9041 (1950)] do not necessarily invalidate the basic assumptions of plasticity theory, and that they are compatible with the author's theory of plastic buckling of plates. J. G. OLDROYD

539.374

5830. The use of plasticine models to simulate the plastic flow of metals. A. P. GREEN. *Phil. Mag.*, **42,** 365–73 (*April*, 1951).

The behaviour of plasticine when permanently deformed is compared with that of an ideal metal, and the necessary conditions for similarity between their flow patterns are examined for flow in two and three dimensions. A brief account of the mechanical properties of plasticine includes a description of stress–strain curves obtained by compressing cylinders between lubricated plates at constant rates of loading. Plane strain experiments, using a plasticine model marked with a grid on a cross-section parallel to the plane of flow, are described, and photographs of the deformed grids are compared with theory. The processes thus examined were: extrusion through square and wedge-shaped dies; indentation of a plane surface by a single wedge and by a row of wedges; and compression of a narrow wedge by a flat die. The profile of a deep narrow block after a small indentation by a flat punch is also compared with theory. All these plane strain plasticine experiments agree well with theory. One experiment using a metal was performed—the compression of a narrow copper wedge by a smooth flat die. This copper wedge deformed in a similar way to the plasticine wedge. A.

539.374

5831. A theory of the plastic distortion of a polycrystalline aggregate under combined stresses. J. F. W. BISHOP AND R. HILL. *Phil. Mag.*, **42,** 414–27 (*April*, 1951).

A general relationship between stress and plastic strain in a polycrystalline aggregate is derived for any metal in which individual crystals deform by slipping over preferred planes under a critical shear stress. Full account is taken of the non-uniform distortion due to mutual constraints between the grains of an aggregate. It is shown that a plastic potential exists which is identical with the yield function. Upper and lower bounds are obtained for an approximate calculation of this function for any applied system of combined stresses. A.

539.374

5832. The plastic deformation of pure single crystals of lead and copper. P. W. NEURATH AND J. S. KOEHLER. *J. Appl. Phys.*, **22,** 621–6 (*May*, 1951).

Single crystals of 99·999% pure Pb and Cu were grown by the Bridgman method. A tensile creep

apparatus is described. Measurements on Cu at 23°c and at −190°c show that for resolved shearing stresses below 0·6 kg per mm² the steady-state creep rate is negligible (i.e. less than 10^{-6} per min). The resolved yield stress for Cu is 219 ± 21 g per mm² at both the temperatures used. In the case of Pb, for resolved shearing stresses below 0·13 kg per mm² the steady-state creep is negligible at −190°c. The yield stress at that temperature is 96 ± 8 g per mm². Measurements were made on the steady-state creep of Pb at 25°c and 110°c. The results produced by annealing were investigated. A.

539.42

5833. Some mechanical properties of graphite at elevated temperatures. C. Malmstrom, R. Keen and L. Green, Jr. *J. Appl. Phys.*, **22**, 593–600 (*May*, 1951).

The short-time tensile breaking strength of various grades of graphite was measured as a function of temperature from room temperature to the sublimation point. A characteristic common to all the strength *v.* temperature curves is that the strength approximately doubles in going from room temperature to about 2 500°c and then decreases rapidly to zero near the sublimation point. Graphite can be used as a structural material at temperatures much higher than those permissible with other materials. The density distribution within an original block is given for grade EBP graphite. The creep characteristics of grade ECA graphite under tensile stress at elevated temperatures were investigated. The testing temperature ranged from 2 200 to 2 900°c while the applied stress varied from 500 to 5 500 lb/in². The range of "steady" creep rates measured extended from 3×10^{-8} to 2×10^{-4} in per in per sec. The activation energy and change in entropy defined by rate theory were calculated for the above conditions. Low frequency dynamic measurements of the Young's modulus of grade ECA graphite made at temperatures from 1 000 to 2 000°c showed an increase of the modulus with temperature. A.

539.43

5834. Some new observations on the mechanism of fatigue in metals. W. A. Wood and A. K. Head. *J. Inst. Met.*, **79**, 89–102 (*April*, 1951).

The response of the crystalline structure of a metal to static stressing has been compared by X-ray diffraction methods with its response to cyclic, or fatigue, stressing. The essential difference is that static stressing produces an extensive and progressive disorientation of the internal structure of the grains, whereas under cyclic stressing this derangement is largely suppressed. The degree of suppression is shown to depend in part on the alternating character of the deformation under cyclic stress, though it depends also on the rate of alternation, there appearing to be a critical rate above which suppression of the disorientation sets in abruptly. It is inferred that if a grain is subjected suddenly to a stress greater than the normal yield stress and then allowed to deform in its own time, there is a delay period before any appreciable plastic strain occurs. It would appear reasonable to assume also that this inhibition of unidirectional deformation transforms a normally ductile metal into a brittle medium, and thus accounts for some of the factors in failure by fatigue. A.

539.43

5835. Measurement of tensile strength of suture materials. S. P. Steward. *J. Sci. Instrum.*, **28**, 114–15 (*April*, 1951).

A horizontal track, carrying a weighted trolley, is allowed to tilt under the force of gravity. The rate of tilting is controlled by a piston provided with a leak moving in a cylinder of oil. The material to be tested is attached to a fixed point and to one end of the trolley. As the track tilts a drum driven by a friction drive rotates and on paper covering its surface a writing point records the extension of the material and the load at which it breaks. A.

539.431

5836. Fatigue fracture of steel. T. Yokobori. *J. Phys. Soc. Japan*, **6**, 81–6 (*March–April*, 1951).

Fatigue fracture of steel has been investigated, and the consideration developed here will in general hold for other metals. This line of thought may be applied to many other cases such as static fracture of brittle metals and yielding of polycrystalline metals. A.

539.434

5837. Delayed fracture in creep of copper. T. Yokobori. *J. Phys. Soc. Japan*, **6**, 78–81 (*March–April*, 1951).

The fluctuation phenomena on the creep fracture in Cn were investigated experimentally. The observed fluctuations of time required for the occurrence of fracture after the application of load were analysed statistically, and it was shown that these creep fractures may be understood as a kind of rate process. A.

539.434

5838. Creep of high-purity aluminum. W. D. Jenkins. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 310–17 (*April*, 1951).

A study was made of cold-drawn aluminium at 105°F, to determine the effects of variations of creep rate on the mechanism of deformation. Strain-hardening was found to decrease monotonically with increase in strain during first stage of creep. The extension on loading and the extension at the beginning of the third stage both increased with increase in stress. Cyclic temperature changes appeared to increase the ductility. Discontinuous flow was evidenced in constant-load creep tests at 105°F and in tensile tests conducted at 80°F. Conformance to Andrade's law of transient flow was found within a limited range of strain rates. Sigmoidal curves were produced that depicted the relationship between stress and creep rate. A mechanism of flow based on observed structural changes is proposed. A.

539.434

5839. Three basic stages in the mechanism of deformation of metals at different temperatures and strain-rates. W. A. Wood, G. R. Wilms and W. A. Rachinger. *J. Inst. Met.*, **79**, 159–72 (*May*, 1951).

In previous work [Abstr. 3509 (1949), 2727, 9049 (1950)] the replacement of slip by the cell mechanism, in Al, has been described. In this mechanism the deformation involves a dissociation of the grains into separate elements that increase in size with increase in temperature and decrease in strain-rate. It is shown in the present paper that by further reduction in the strain-rate at an elevated temperature, the cell mechanism is in turn superseded; this occurs when the

cells become comparable in size with the grain itself. This third stage is termed "boundary micro-flow." The nature of the observations suggests that no other major change is likely to be observed as the rate of strain is further reduced. A.

539.53

5840. Damaged impressions in microhardness testing. P. GRODZINSKI. Letter in *Research, Lond.*, **4**, 140–1 (*March*, 1951).

539.53 : 621–52 : 620.178.1

5841. An automatic light-load Bergsman type hardness tester. P. GRODZINSKI. *J. Sci. Instrum.*, **28**, 117–21 (*April*, 1951).

By means of special equipment, fully automatic control has been applied to the operation of a stronger model of a Bergsman type light-load hardness tester used in association with a Vickers projection microscope. The reliability of hardness testing has been increased by eliminating manual control of the indenting operation and by redesigning the indenter. A.

539.62

5842. Statistical features in static friction. H. NAGASU. Note in *J. Phys. Soc. Japan*, **6**, 123–4 (*March–April*, 1951).

539.893

5843. High-pressure apparatus for compressibility studies and its application to measurements on leather and collagen. C. E. WEIR. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 468–76 (*Dec.*, 1950).

The design and construction of apparatus to be used to measure volume changes of solids (or liquids) between 1 000- and 10 000-atmosphere pressure is described in detail. Calibration of the equipment and its use in determining the compression ($-\Delta V/V_0$) of leather are discussed. The compression of leather between 1 000 and 10 000 atmospheres is reported. A.

539.893

5844. Compressibility of natural and synthetic high polymers at high pressures. C. E. WEIR. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 207–12 (*March*, 1951).

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.1 : 530.145

5845. Quantum theory in chemistry. P. HARTECK. *Naturwissenschaften*, **38** (*No.* 3) 61–7 (1951) *In German.*

A review of fields of application since Nernst. These include photochemistry, and atomic and molecular spectroscopy in relation to gas kinetics, isotope theory and determination of chemical constants.

J. JACOBS

541.115 : 536.2

5846. On the energetic treatment of non-isothermal processes. The principle of thermal interaction. H. HOLTAN, JR. *J. Chem. Phys.*, **19**, 519–25 (*May*, 1951).

The existing theories for non-isothermal processes are discussed. A new hypothesis, "the principle of thermal interaction" is introduced by employing Onsager's principle of reciprocity and is expressed in terms of Brønsted's energetics. It states that there is an interaction between the flow of heat and the transport phenomena in a non-isothermal process in such a way that the loss of work (loss of potential energy) for the transport of entropy bound to chemical substance can be compensated partly or completely by the transport of free entropy contained in the flow of heat in the opposite direction. The result is that any particle will tend to move against the temperature gradient. The principle is applied to thermocells with a solid electrolyte, and the results shown to agree with experimental data. The Knudsen equation, applicable to a thermal transpiration cell, is derived without employing the kinetic theory of gases. A.

541.122

5847. The measurement of chemical equilibria by means of the critical flow orifice. H. WISE AND D. ALTMAN. Letter in *J. Chem. Phys.*, **19**, 516 (*April*, 1951).

An expression is deduced for the mass-flow rate of a mixture of gases in equilibrium state through the critical orifice. The experimental values of the equilibrium compositions of gas mixture $N_2O_4 \rightleftarrows 2NO_2$ at two temperatures and various pressures, as obtained from the expression, compare well with values calculated on the basis of equilibrium constants.

F. LACHMAN

541.123.2

5848. Critical limits of metastability in binary systems. H. REISS AND L. FRIEDMAN. Letter in *J. Chem. Phys.*, **19**, 253–4 (*Feb.*, 1951).

An attempt at comparing the available experimental data relating to the kinetics of phase transitions in binary systems with theoretical deductions contained in a recently published treatment of this kinetics.

F. LACHMAN

541.123.5

5849. The exchange of water between hydrated cations and solvent. J. P. HUNT AND H. TAUBE. *J. Chem. Phys.*, **19**, 602–9 (*May*, 1951).

The rate of exchange of water between the hydrated forms of Al^{+++}, Cr^{+++}, Fe^{+++}, Ga^{+++} and Th^{+4}, and the solvent water has been measured in solutions of varying acidity. With the exception of chromic ion, and of ferric ion at low acidity, the exchange is complete in c. 3 min at 25°. For chromic ion, the half-time for exchange is independent of acidity over a wide range and is c. 40 hr at 1 M salt concentration. The co-ordination number of chromic ion for water over the entire acidity range is 6·0. The initial hold-back of O by ferric ion at low acid is slight and is attributed to the presence of polynuclear hydrolyzed species. For all the cations, the distribution of O isotopes in the final solution is noticeably different from random, the cations showing a greater

affinity for H_2O^{18} over H_2O^{16}. The rates of exchange are correlated with the electronic structure, which influences the energy required to form the transition state. A.

541.123.5 : 541.183

5850. Isotopic exchange rates as criteria of surface heterogeneity. R. P. Eischens. Letter in *J. Chem. Phys.*, **19**, 377 (*March*, 1951).

The kinetics of the exchange of CO chemisorbed on reduced Fe, with gaseous CO, has been studied with $C^{14}O$. The data can be represented by a small number of straight lines, each corresponding to a portion of the surface which is homogeneous in itself. S. J. GREGG

541.124

5851. The decomposition of excited ethylene. B. deB. Darwent. Letter in *J. Chem. Phys.*, **19**, 258 (*Feb.*, 1951).

Excited ethylene molecules can decompose on the wall, rather than merely lose their energy there. The mechanism of the process has been studied by carrying out the reaction in the presence of low concentrations of Hg vapour. S. J. GREGG

541.124

5852. The thermal decomposition of nitromethane. L. J. Hillenbrand, Jr., and M. L. Kilpatrick. Letter in *J. Chem. Phys.*, **19**, 381 (*March*, 1951).

Describes the results of a study of thermal decomposition of CH_3NO_2 carried out by the flow method, with N as carrier gas. F. LACHMAN

541.124

5853. Determination of an isotope effect in the decarboxylation of malonic-1-C^{14} acid. A. Roe and M. Hellmann. Letter in *J. Chem. Phys.*, **19**, 660 (*May*, 1951).

541.124 : 539.16

5854. Study of the carbon dioxide–carbon reaction using C^{14} as a tracer. F. Bonner and J. Turkevich. *J. Amer. Chem. Soc.*, **73**, 561–4 (*Feb.*, 1951).

Radiocarbon C^{14} has been used to study the reaction between CO_2, CO and charcoal using a recycling system with continuous monitoring of the radioactivity of the gaseous components of the system. Radiochemical measurements were correlated with changes of composition of the gas and with pressure measurements. The data obtained were interpreted in terms of a mechanism which postulates a rapid reaction of the CO_2 with the surface to give an oxygenated surface and a radioactive CO and a subsequent slow two-stage unimolecular decomposition of the oxygenated surface into non-radioactive CO and charcoal. A.

541.124.7

5855. Dissociation of sulphur vapour. H. Braune, S. Peter and V. Neveling. *Z. Naturforsch.*, **6a**, 32–7 (*Jan.*, 1951) *In German.*

New measurements of dissociation in S-vapour have shown that, contrary to previous theory, the interpretation of experimental results is only possible when S_4-molecules are taken into consideration. The heats of the various dissociation reactions and of the reaction $S_{rhomb} \rightleftarrows S_{2}\text{-vapour}$ have been calculated from the data obtained. F. LACHMAN

541.127

5856. Oxidation kinetics of nickel and cobalt. W. J. Moore and J. K. Lee. Letter in *J. Chem. Phys.*, **19**, 255 (*Feb.*, 1951).

Presents the results of an investigation on the kinetics of the formation of oxide films on Ni and Co in the temperature range 400–900°c for Ni and 500–800°c for Co, the pressure of O being 10 cm. F. LACHMAN

541.127

5857. Aspects of polymerization at high pressures. F. M. Merrett and R. G. W. Norrish. *Proc. Roy. Soc. A*, **206**, 309–34 (*May* 7, 1951).

The catalyzed polymerization of styrene at pressures in the range 0 to 5 000 kg/cm² has been studied by an improved technique utilizing a closed system containing a very sensitive electrical resistance pressure gauge. Correlation of the results obtained by this method with the more usual analytical methods has given reliable results for the rates and molecular weights over the observed initial period of the polymerization. A.

541.128

5858. Activation of a solid nickel catalyst for the hydrogenation of ethylene by heat treatment in a high vacuum. R. K. Sherburne and H. E. Farnsworth. Letter in *J. Chem. Phys.*, **19**, 387–8 (*March*, 1951).

Prolonged outgassing at dull red heat of a smooth nickel surface markedly increases its catalytic activity because of the removal of adsorbed impurity. S. J. GREGG

541.128 : 541.64

5859. Autocatalysis in protein-systems and negative catalysis. A. Goudot. *C.R. Acad. Sci., Paris*, **232**, 1078–80 (*March* 12, 1951) *In French.*

Biological macromolecules, genes of viruses, interact with groups of liquid chain-molecules. Phenomena similar to the Winter effect then explain how a macromolecule may promote negative catalysis in some reactions, positive in others. J. JACOBS

ELECTROCHEMISTRY 541.13

541.132

5860. First dissociation constant of succinic acid from 0° to 50°c and related thermodynamic quantities. G. D. Pinching and R. G. Bates. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 444–9 (*Dec.*, 1950).

541.132 : 539.153.1

5861. The polarisabilities and the radii of ions in solution. C. J. F. Böttcher and T. G. Scholte. *Rec. Trav. Chim. Pays-Bas.*, **70**, 209–35 (*March*, 1951).

A method for the calculation of the polarizabilities and radii of ions in solution previously developed by one of the authors is applied to solutions of salts in

mixtures of water and glycerol, to aqueous solutions of KF and to solutions of aluminium chloride in dilute hydrochloric acid. From the results of the measurements a further discussion of the method is given. A.

541.134

5862. Hydrogen overvoltage and potential build-up at copper cathodes. A. K. WIEBE, W. GAUVIN AND C. A. WINKLER. *Canad. J. Chem.*, **29**, 301–7 (*April*, 1951).

A given current (e.g., 10^{-4} A.) results generally in a nonlinear hydrogen-overvoltage/time relation at a Cu cathode immersed in N/5 sulphuric acid. After a steady state value of the potential is reached, which may require several minutes, breaking the circuit allows the potential to fall slowly to the zero potential value. On again closing the circuit, a current of the same order as before causes, in a time of the order of seconds, a linear potential build-up to a value equal to the steady state hydrogen overvoltage. Taking the capacitance of a uniplanar surface as 20 μf/cm^2, the rate of the linear potential build-up permits estimation of cathode surface areas (Bowden and Rideal method). If it is now assumed that the nonlinear increase of hydrogen overvoltage with time is accompanied by deposition of a monatomic layer of hydrogen on the surface, the area occupied by this layer can be estimated. The area so calculated agrees as well as may be expected with that determined by the Bowden–Rideal method. It is concluded that the Bowden–Rideal measurement depends on the rate of charging a condenser, as distinct from the rate of increase of hydrogen overvoltage, which may be associated with deposition of a layer of hydrogen on the cathode surface. Evidence is further presented to indicate that the surface is completely covered with the layer of hydrogen at the maximum of hydrogen overvoltage, and that the Bowden–Rideal method therefore measures the true surface area of the cathode. A.

541.135

5863. Free energy of the double layers of two plates at large separations. S. LEVINE AND A. SUDDABY. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 431–3 (*April*, 1951).

See Abstr. 3861 (1951). The next term in the expansion is obtained and a table of the coefficients given.

541.135 : 532.613

A wedge effect at amalgam/electrolyte surfaces. *See Abstr.* 5154

541.135.2

5864. Macroscopic space charge in a potassium chloride solution during electrolysis. W. SCHRIEVER AND E. E. FERGUSON. *J. Chem. Phys.*, **19**, 609–12 (*May*, 1951).

The macroscopic space charge and potential distributions were determined in a uniform column of 0·0024 *N* KCl solution during electrolysis by the methods used by Reed and Schriever. For the first time, all 4 space-charge regions were observed in one column of solution directly experimentally. The maximum — ve space charge in the cathode region, 45×10^{-5} statcoulomb/cm^3 at $x = 0{\cdot}6$ cm, and the maximum + ve space charge in the anode region, 40×10^{-5} statcoulomb/cm^3 at $x = 37{\cdot}7$ cm. The potential gradient between $x = 10$ cm and $x = 35$ cm had the constant value of 13·75 mV/mm. The mean gradient in the first mm next to the cathode was 1 130 mV/mm; that in the last mm next to the anode was 1 200 mV/mm. It is pointed out that the shapes of the potential distribution curves cannot be explained by phenomena which occur only at, and very near, the electrodes. A.

541.135.64

5865. Mechanism of the depolarizing and catalytic activity of manganese dioxide. J. BRENET AND A.-M. BRIOT. *C.R. Acad. Sci., Paris*, **232**, 1300–2 (*March* 28, 1951) *In French.*

Previous work [see Abstr. 698 (1951)] is extended, and various thermal treatments of active MnO_2 are described with respect to the depolarization properties exhibited. The influence of a new crystalline phase is established, which may well be the cause of the depolarizing and catalytic activities of the active compounds, as well as a determining factor in their electrochemical potentials. H. H. HODGSON

541.138

5866. Variations of oxidation-reduction potential during the precipitation of ferrous and ferric hydroxides. M. QUINTIN. *C.R. Acad. Sci., Paris*, **232** 1303–5 (*March* 28, 1951) *In French.*

Measurements at 20° (under N_2) of the precipitation of ferrous and of ferric salts (e.g. $FeCl_2$ and $FeCl_3$) by bases, indicate, from the slopes of the curves representing the oxidation-reduction potential Fe^{++}/Fe^{+++} as a function of the *p*H, no accord with precipitates in the states of $Fe(OH)_2$ or $Fe(OH)_3$, but an equilibrium between both states. This may be due, e.g. in the case of $FeCl_2$ to some initial evolution of ferric precipitation followed by autoxidation of the main ferrous hydroxide precipitate. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14/.15

5867. Studies in photochemistry and radiation chemistry of toluene, mesitylene and ethylbenzene. R. R. HENTZ AND M. BURTON. *J. Amer. Chem. Soc.*, **73**, 532–6 (*Feb.*, 1951).

Light absorbed in the 2 537 Å region, presumably by the π-electron system, produces gas non-condensable at — 120° with a quantum yield of the order of 10^{-4}. Quantum yields of molecules converted to polymer are roughly 16 times greater. The major primary photolysis occurs in bonds β to the ring with an additional small contribution from C–C bonds α to the ring. Atoms and radicals formed may add to a benzene ring, acquire a H atom from a methyl group in a molecule, or combine. Liquid state photolyses show considerable suppression of methane formation. Hg-photosensitized decomposition of toluene and mesitylene gives low yields of H. In 1·8 MeV electron-induced radiolysis, 100 eV yields of non-condensable gas range from 0·14 for toluene

to 0·26 for mesitylene; i.e., about 100 times greater than might be expected on a mere energetic basis by comparison with quantum yields. Radiolysis results are interpreted on the basis of energy absorption in either the ring or the side group, flow of energy from one to the other, and ensuant decomposition, the energy-yield of the latter being decreased by fluorescence from the π-electron system of the ring. A.

541.14

5868. The decomposition of radicals produced by mercury photo-sensitization. A. F. TROTMAN-DICKENSON. Letter in *J. Chem. Phys.*, **19**, 261 (*Feb.*, 1951).

Results of 2 recently published studies have been recalculated, the additional assumption being that the reactions take place uniformly throughout the cell. Several conclusions reached have been discussed. F. LACHMAN

541.14

5869. The photochemical reaction between ozone and hydrogen peroxide. D. H. VOLMAN. *J. Amer. Chem. Soc.*, **73**, 1018–22 (*March*, 1951).

The thermal and photochemical gas phase reactions of O_3 and H_2O_2 in a flow system were studied with the object of elucidating the mechanisms of the reactions. The thermal reaction was found to be heterogeneous and to proceed rapidly in the presence of Hg vapour or mercuric oxide on the walls. For the photochemical reaction, the absence of long chains and the presence of HO radicals was shown. The proposed mechanism postulates an initiation of the reaction by interaction of O atoms formed by ozone light absorption and H_2O_2 with the formation of HO and HO_2 radicals. The kinetic equations developed from the proposed mechanism were in agreement with the experimental results. A.

541.14

5870. The effect of temperature on the photolysis of methylamine. C. I. JOHNSON AND H. A. TAYLOR. *J. Chem. Phys.*, **19**, 613–17 (*May*, 1951).

The photolysis of methylamine has been investigated with the purpose of determining the effect of temperature. To minimize the interference due to polymeric liquid formation, the reaction was studied from — 15° to 30°C. The energy of activation of amine disappearance was found to be 6 kcal, a minimum value, but which is probably caused by the effect of temperature on the light absorption. The possibility of ethylene diamine as an intermediate undergoing further decomposition or a polymerization-condensation reaction evolving NH_3 is considered. The rates of H and NH_3 production show previously postulated mechanisms to be untenable. A.

541.14 : 535.343–34

5871. Ultra-violet absorption bands of photochemically-treated crystals of potassium chloride and bromide. H. DORENDORF. *Z. Phys.*, **129** (*No.* 3) 317–26 (1951) *In German.*

The absorption spectra in the range 0·2 to 1μ of KCl and KBr crystals which have been irradiated with X-rays in the temperature range — 180° to + 75° have been measured. In addition to the *F*-bands in the visible, 7 absorption bands (*V*-bands) have been observed in the ultra-violet; of these only 3 have previously been reported. The form of the absorption spectrum depends to a large extent on the irradiation temperature. For very low temperatures (— 180°) the V_1- and V_5-bands corresponding to pure electron transitions predominate. They become less important as the temperature is increased. For irradiation temperatures of — 100° to — 50° the V_4-, V_2- and V_3-bands predominate; ionic diffusion processes are responsible for their production. At these temperatures the V_6- and V_7-bands are present, but are weak. By suitable heat treatment the *V*-bands can be converted into each other. Above 100° all the *V*-centres disappear chiefly by thermal recombination with *F*-centres. A. J. MEI

541.1

5872. Effect of the radiation of an atomic pile on water and on solutions of boron. P. BONÉT-MAURY and A. DEYSINE. *C.R. Acad. Sci. Paris*, **232**, 1101–3 (*March* 12, 1951) *In French.*

After several days of irradiation in the maximum flux of the ZOE (Chatillon) pile, a concentration of a few γ/ml of H_2O_2 has been found in water. The irradiation of aqueous solutions of H_2O_2 (both free and in the coloured Ti complex) causes its decomposition. Some experiments indicate that the formation of H_2O_2 is primarily due to γ-radiation. The addition of a few thousandths of B (H_3BO_3 + N borate to *p*H7, or H_2BO_3 to *p*H5) alters the process of H_2O_2 both qualitatively and quantitatively. The concentration of H_2O_2 is increased 50–100 times and remains proportional to the number of ion pairs per cubic centimetre. The consistency of results renders it possible to use the simple and exact colorimetric method of H_2O_2 determination for the dosage of slow neutrons. Irradiated water has an activity corresponding to the order of from several hundred to several thousands of discharges in the Geiger-Müller counter per minute per millilitre, irrespective of the chemical composition of the walls of the tube or of the degree of purity, or the origin, of water used. F. LACHMAN

541.1

5873. Radiation chemistry of ferrous sulfate solutions. E. J. HART. Letter in *J. Amer. Chem. Soc.* **73**, 1891–2 (*April*, 1951).

Demonstrates that, on the basis of the accepted $FeSO_4$ oxidation mechanism, theoretical values less than 4·0 are possible for *R*, the yield ratio, $Fe^{+++}_{(O_2)}$/Fe^{+++}_{vac}, obtained by X-ray or γ-ray irradiation of dilute solutions of $FeSo_4$ in the presence and absence of air. F. LACHMAN

541.15 : 537.5

5874. Elementary processes in radiation chemistry. II. Negative ion formation by electron capture in neutral molecules. J. L. MAGEE AND M. BURTON. *J. Amer. Chem. Soc.*, **73**, 523–30 (*Feb.*, 1951).

See Abstr. 7567 (1950) for part I. Ionization processes characteristic of radiation chemistry yield energetic electrons which are ultimately degraded to thermal energies in ionization and collision processes. Although negative ions can be produced without positive-ion formation by impact of energetic electrons on molecules, the yield

of such processes is so small that they make practically no contribution to the over-all picture. Thermal electrons can yield negative ions either in simple capture or in dissociative capture processes. When conditions for negative ion formation are satisfactory, low energy electrons ($< \frac{1}{4}$ eV in gases, $\frac{1}{4}$ eV in liquids) disappear almost exclusively in formation of negative ions rather than in neutralization of positive ions. Radiation chemical syntheses of O_3 and of H_2O_2 show behaviour characteristic of reactions in which the principal neutralization process involves negative O ions. When a negative-ion source (e.g., O or water) is present as impurity in a substance of low ionization potential (e.g., benzene), the principal neutralization reaction in a radiation-chemical process involves interaction of the negative ion of the former and of the positive ion of the latter. Resultant characteristic reactions may mask the normal radiation-chemical reaction of the uncontaminated principle constituent. Water vapour captures thermal electrons without dissociation but solvation of the negative ion in liquid water confers large electron affinity and produces a situation conducive to capture accompanied by dissociation. Resultant anisotropic distribution and high concentration of positive and negative ions may have special consequences, particularly in biological systems. A.

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.182.3 : 537.2

5875. An electrical method for investigating the nature and behavior of small, airborne, charged particles. J. H. Daniel and F. S. Brackett. *J. Appl. Phys.*, **22**, 542–54 (*May*, 1951).

A theoretical and experimental analysis of the current-voltage (d.c.) characteristic of a parallel-plate condenser through which the small, airborne, charged particles of an aerosol are passed continuously shows that a charge-weighted distribution of radius (or radius squared)-charge ratio may be obtained when certain experimental conditions are satisfied. Examination of such a distribution for an aerosol (particles less than a micron in diameter) before and after passage through a small (20l) settling chamber shows that the classes of particles in the distribution that are easiest to collect in the condenser are also the classes that disappear most rapidly in the chamber. It is pointed out that the methods employed would become less tedious and more powerful when used with a dispersion of constant-size particles, and that they are well adapted for certain fundamental investigations of aerosol properties. A.

541.182.6 : 539.27

5876. Electron microscopy of nickel hydroxide sols. D. Bagno, J. Longuet-Escard and A. Mathieu-Sicaud. *C.R. Acad. Sci., Paris*, **232**, 1350–2 (*April* 2, 1951) *In French.*

Sols of $Ni(OH)_2$ are examined by the electron microscope after (*a*) ageing at 20°, (*b*) heating sols so aged at 40°, 60° and 80° and (*c*) flocculating with CO_2 gas. Details are given of the various changes observed. J. THEWLIS

541.183

5877. A new adsorption isotherm. K. Krishnamurti. *Proc. Indian Acad. Sci. A*, **33**, 92–6 (*Feb.*, 1951).

A new adsorption equation has been derived for those cases of adsorption where the previously adsorbed molecules facilitate the adsorption of more molecules striking the surface of the adsorbent. This equation fits in well with the adsorption data yielding the familiar S-shaped curves and should find extensive application. A.

541.183

5878. The adsorption isotherm of Langmuir and of Brunauer, Emmett, and Teller for multilayers where *n* is 2. D. C. Jones and E. W. Birks. *J. Chem. Soc.* (1951) 1127–30 (*April*).

The realizable isotherms show interesting changes of type as σ_1/σ_2 or c reaches certain critical values, σ_1 and σ_2 being the relative lives of adsorbed molecules in the first and second layers respectively: the B.E.T. assumption, that $\sigma_2 = \sigma_{\text{liquid}}$, need not be made in this case. For $c = 4$ the isotherm is a rectangular hyperbola, passing through the origin and therefore, for this case, bilayer adsorption on this model gives an isotherm of the same form as that given by the Langmuir monolayer equation. Deviations from the hyperbola occur as $c \lesssim 4$ and the deviations are simply related to the value of c. A.

541.183 : 530.162

5879. Statistical mechanics of adsorption from multicomponent systems. I. S. Ono. *J. Phys. Soc. Japan*, **6**, 10–15 (*Jan.–Feb.*, 1951).

Discusses the adsorption from a multicomponent system by using the theory of McMillan and Mayer [Abstr. 3000 (1945)]. An equation for the molecular distribution near the surface of the adsorbent and another for the adsorption isotherm have been derived. F. LACHMAN

541.183 : 530.162

5880. Liquid-vapour transition region and physical adsorption according to van der Waal's equation. T. L. Hill. Letter in *J. Chem. Phys.*, **19**, 261–2 (*Feb.*, 1951).

Theoretical. The statistical-mechanical foundation of van der Waal's equation is used, and the method proposed can be extended to solutions, to liquid-liquid interfaces and to adsorption from a mixture of gases. S. J. GREGG

541.183 : 531.724

5881. Thermal effects during adsorption. I. Application for the measurement of the surface area of powders. E. Calvet. *C.R. Acad. Sci., Paris*, **232**, 964–6 (*March* 5, 1951) *In French.*

An abrupt discontinuity, corresponding to the end of the formation of the unimolecular film, has been detected in the $\Delta\theta/m$ curve recording, by a microcalorimetric method, the heat evolved when a dry adsorbent is immersed into a liquid. A new simple

method for measuring the true surface area of a powdered substance without previous degassing has been developed. F. LACHMAN

541.183 : 537.311.33

5882. Adsorption on semiconductors. P. AIGRAIN, C. DUGAS AND J. GERMAIN. *C.R.Acad. Sci., Paris*, **232**, 1100–1 (*March* 12, 1951) *In French.*

An attempt at explaining the adsorption of certain gases on certain semiconductors by purely electrostatic phenomena. The energies of adsorption and number of adsorbable atoms calculated are in good agreement with certain experimental results. F. LACHMAN

541.183 : 539.16.08

5883. Radiotracer study of cationic surface-active agents by measurement of gegenion adsorption. C. M. JUDSON, A. A. ARGYLE, J. K. DIXON AND D. J. SALLEY. Letter in *J. Chem. Phys.*, **19**, 378 (*March*); errata, 661 (*May*, 1951).

Solutions of stearamidopropyldimethyl-2-hydroxylethyl ammonium sulphate (Aerosol SE sulphate) were labelled with $Na_2S^{35}O_4$ and the β-activity over the surface measured. Results indicate that adsorbed multilayers are formed at the surface and that the gegenion may be in part OH^- and in part SO_4^{--}. S. J. GREGG

541.183 : 541.123.5

5884. Application of the mass law to adsorption of divalent ions on hydrous ferric oxide. M. H. KURBATOV, G. B. WOOD AND J. D. KURBATOV. Letter in *J. Chem. Phys.*, **19**, 258 (*Feb.*, 1951).

The hydrous ferric oxide is regarded as an ion exchanger and the law of mass action is applied. Results in accordance with expectation are obtained for the adsorption of Sr, Ba, Ra and Co ions from 10^{-9} molar solution. S. J. GREGG

CHEMICAL STRUCTURE 541.4/.6

541.5

5885. Transformation of water from covalent to electrovalent combination in formic acid–water mixtures. T.-Y. YANG. *J. Chem. Phys.*, **19**, 647–8 (*May*, 1951).

It was shown by the author [Abstr. 2791 (1949)] that water was necessarily a covalent compound, the molecule of which is formed by the neutralization of $2H^{+1} + 2\theta + O^{+2}$. In the present paper it is shown that, in formic acid–water mixtures, part of the water depending on the weight of formic acid in the mixtures changes its specific susceptibility from $-0{\cdot}72$ to $-0{\cdot}625$. This indicates that this part of the water in the process of mixing transforms from a covalent to an electrovalent combination. A.

541.57

5886. The calculation of coefficients of Coulomb and exchange integrals in matrix elements involving polar singlet structures. M. SIMONETTA AND V. SCHOMAKER. *J. Chem. Phys.*, **19**, 649–53 (*May*, 1951).

Starting from Pauling's rules for calculating matrix elements for covalent structures, it is shown how to extend the valence-bond treatment to polar structures. Attention is called to the new types of integrals which are involved and simple procedures for evaluating their coefficients are described. A.

541.57 : 536.666

5887. The effect of halogenation on the C–Br bond dissociation energy in halogenated bromomethanes. M. SZWARC AND A. H. SEHON. Letter in *J. Chem. Phys.*, **19**, 656–7 (*May*, 1951).

541.57 : 536.666

5888. The influence of aromatic substitution on the C–Br bond dissociation energy. M. SZWARC, C. H. LEIGH AND A. H. SEHON. Letter in *J. Chem. Phys.*, **19**, 657–8 (*May*, 1951).

541.6 : 548.736

5889. The structure of synthetic polypeptides. III. The molecular configurations and physical properties of some regenerated synthetic polypeptides. C. H. BAMFORD, W. E. HANBY AND F. HAPPEY. *Proc. Roy. Soc. A*, **206**, 407–24 (*May* 7, 1951).

See Abstr. 3172 (1951) for Part II.

541.62

5890. Relative stabilities of methylacenes and methylenedihydroacenes. E. HÜCKEL AND B. KRAUSE. *Z. Naturforsch.*, **6a**, 112–16 (*Feb.*, 1951) *In German.*

Clar [*Chem. Ber.*, **82**, 495 (1949)] and Clar and Wright [Letter in *Nature, Lond.*, **163**, 921 (*June* 11, 1949)] concluded from spectrometric measurements that the equilibrium which occurs between the tautomeric methylacenes and methylenedihydroacenes favours the methyl-form for the compounds with lower ring numbers and the methylene-form for those with higher ring numbers and also for those symmetrically substituted. Calculations of the resonance energies of the π-electrons according to the method of molecular electronic states have afforded a satisfactory interpretation of these relationships. H. H. HODGSON

541.64

5891. Markoff chains and chain molecules. K. SUZUKI. Letter in *J. Chem. Phys.*, **19**, 385 (*March*, 1951).

Theoretical. It is shown that the use of transition probability in treating the volume effect of polymer chains will lead to false results [see E. W. Montroll, *J. Chem. Phys.*, **18**, 734 (1950)]. J. IBALL

541.64 : 535.435

5892. Light scattering studies on coiling polyelectrolytes. F. T. WALL, J. W. DRENAN, M. R. HATFIELD AND C. L. PAINTER. *J. Chem. Phys.*, **19**, 585–8 (*May*, 1951).

The molecular weight and size of polyacrylic acid in solution have been determined by measurement of light scattering. Use was made of Debye's 90° light-scattering method employing two different wavelengths of light. The weight-average molecular weight of a certain sample of polyacrylic acid at *p*H values of 1·2, 3, 4 and 5 was found to be 206 000 ± 10%. The size of the particles in solution was found to be < 550 Å in the low *p*H regions, with a definite tendency to increase at higher *p*H values. The slope of the straight line obtained when the reciprocal

specific scattering was plotted against concentration was shown to be dependent upon *p*H. This dependence of slope may be related to particle size and shape. In a non-ionizing solvent such as ethanol, the polymer exhibits scattering behaviour typical of non-ionized polymers. The molecular weight of polyacrylic acid under these conditions was found to be 206 000, in agreement with values obtained in buffer solvents. A.

541.65

5893. Relations between dye phosphors and hydrogen bonds on rigid media or surface of adsorbents. D. Yamamoto and R. Iwaki. Letter in *J. Chem. Phys.*, **19**, 662 (*May*, 1951).

541.654 : 541.265

5894. Refrachor: a new physical constant. S. S. Joshi and G. D. Tuli. Note in *J. Chem. Soc.* (1951) 837–8 (*March*).

The proposed new constant refrachor $[F] = -P\log(n_D^{20} - 1)$ where P is the parachor. It is claimed that the refrachor of a compound is the sum of atomic constants and of constants depending on structural factors. A table of 22 atomic, structural and group refrachors is given. It is suggested that the new constant might prove more useful than parachor when applied to problems of chemical constitution. F. LACHMAN

CHEMICAL ANALYSIS 543/545

545.373

5895. Millicoulometry. I. Construction and operation of an apparatus for the determination of polarographic *n*-values. S. Bogan, L. Meites, E. Peters and J. M. Sturtevant. *J. Amer. Chem. Soc.*, **73**, 1584–7 (*April*, 1951).

The design and calibration of a millicoulometer incorporating a Weston integrating relay and accessory electronic circuits are described. When this instrument is used to integrate the current flowing through a polarographic circuit under such conditions that a considerable decrease in the concentration of reducible or oxidizable material takes place during the electrolysis, data are secured from which the value of *n*, the number of faradays per mole of electrode reaction, can be computed. The application of the method is illustrated by data on some representative inorganic reductions. A.

545.38

5896. Polarography with alternating currents. I. Outline of theory, apparatus, and technique. B. Breyer, F. Gutman and S. Hacobian. *Aust. J. Sci. Res. A*, **3**, 558–66 (*Dec.*, 1950).

A method of polarographic analysis employing the superposition of a small sinusoidal alternating field of low frequency upon the direct potential applied to the dropping Hg electrode has been further developed. Equations are given for the calculation of the ionic concentration from the alternating current (maximum differential current) at the characteristic "summit potential" (analogous to $E_{\frac{1}{4}}$ in conventional polarography). This current is proportional to the concentration of the ion species undergoing discharge. The advantages of the method over conventional polarography can be summarized as follows: (i) A.C. polarography can be carried out in solutions containing dissolved oxygen, i.e. in air. (ii) Tedious curve plotting is substituted by a single current reading at the summit potential which yields directly both the half-wave potential and the concentration of the electro-reducible substance. (iii) Small amounts of less noble ions can be estimated even in the presence of a large excess of nobler ions. (iv) Polarographic waves only 40 mV apart are clearly separable. (v) An improved all round reproducibility is obtained. (vi) There is a simplified system of recalibration in case of capillary replacement. (vii) The use of a delicate galvanometer is eliminated. A.

545.38

5897. Polarography with alternating currents. II. A.c. polarography of cadmium, zinc, lead, thallium, indium, bismuth, and antimony. B. Breyer, F. Gutman and S. Hacobian. *Aust. J. Sci. Res. A*, **3**, 567–80 (*Dec.*, 1950).

The a.c. polarographic waves of Cd, Zn, Pb, Tl, In, Bi and Sb are discussed. A number of factors affecting the magnitude of the maximum differential current, e.g. the effect of series resistance in the cell circuit, amplitude of the a.c. voltage, variation in temperature, variation of supporting electrolyte, presence or absence of air, etc., have been determined. A solution containing a mixture of the above elements was analysed with a.c. polarography and it was found possible to distinguish each wave of the seven elements simultaneously present. This is not possible in conventional polarography. A.

545.8

5898. Thermal analysis of active manganese dioxide. J. Amiel and G. Rodier. *C.R. Acad. Sci., Paris*, **232**, 1209–10 (*March* 19, 1951) *In French.*

Variation of weight with temperature has been examined for normal and catalytic specimens of MnO_2. In all cases an endothermic change at $\sim 320°$ indicates the existence of a hydrate, since the transformation of MnO_2 to Mn_2O_3 is excluded. Two other endothermic points, below 230°, may be due to rearrangement of the Mn and O atoms. In all cases, MnO_2 appears to be normally in a metastable state which changes thermally to one more stable. Catalytic properties, when present, are lost on heating. H. H. HODGSON

545.8 : 539.172.4 : 539.185

Autoradiography of U and Th minerals by neutrons. *See Abstr.* 5807

545.82

5899. Photoelectric spot analysis of antimony and bismuth. T. Sudo and K. Hayase. *Science*, **113**, 11–12 (*Jan.* 5, 1951).

Describes the method and apparatus used for photometric quantitative spot analysis of Sb and Bi ions. The method was used with success for an analysis of a Bi ~ Sb sulphide mineral. F. LACHMAN

CRYSTALLOGRAPHY 548

548.4

5900. A note on the distribution of impurities in alkali halides. E. Burstein, J. J. Oberly, B. W. Henvis and J. W. Davisson. Letter in *Phys. Rev.*, **81**, 459–60 (*Feb.* 1, 1951).

Evidence, derived from optical data, for the formation of impurity aggregates in NaCl crystals containing Pb^{++}. The influence of the growth and thermal history on such deviations from random distribution is discussed. A. J. KENNEDY

548.5

5901. On the crystallization of very thin Au-films. A. Colombani and G. Ranc. *C.R. Acad. Sci., Paris*, **232**, 1344–6 (*April* 2, 1951) *In French.*

The formation of Au-films on crystalline (*c*) and amorphous (*a*) substrates was examined electrically and microscopically as a function of time and the thickness *d*. The thickness at which crystallization begins is 12— atomic layers for (*c*), and 16— for (*a*). For equal thicknesses between 0 and 500 Å, films on (*c*) have a lower resistance, the difference varying inversely as *d*. The rate of crystallization is always greater with (*a*), *d* being kept constant. The electron microscope reveals micro-crystals in apparently continuous surfaces only on (*c*): they are as large as 1 000 Å. Four figs. are given. R. A. WEALE

548.5 : 539.373

5902. The slip, twinning, cohesion, growth and boundaries of crystals. H. Wilman. *Proc. Phys. Soc., Lond. A*, **64**, 329–50 (*April*, 1951).

The nature and stability of intercrystalline boundaries are discussed and conclusions as to preferred relative orientations are illustrated by ball-bearing and bubble-raft models. Electron-diffraction evidence from crystals of layer-lattice, ionic, metallic and van der Waals (organic molecular) types is presented, showing that crystal pairs and symmetrical or unsymmetrical triplet or multiplet crystal groupings occur, having a common lattice row, but in relative azimuthal orientations at intervals agreeing with the predictions. The component crystals were thus in coherent metastable contact of the type discussed, and in some cases strong secondary elastic scattering showed that the crystals were extensively superposed on the plane which was normal to the common row. The seven types of electron-diffraction pattern observed from such groupings, and the nature of the specimen preparation, suggest that the origin of these groupings is a mechanical deformation of the crystals during or after growth, by a process of "rotational slip" which has not hitherto been explored or defined in nature. Such slip is directly demonstrated macroscopically as a deformation process in potassium ferrocyanide trihydrate and gypsum, the slip being produced on the planes parallel to the highly perfect cleavage. The relation between rotational slip and the known types of translational slip and dislocation theory is indicated, and in particular "deformation bands" are concluded to be essentially rotational slip bands initially at low deformation, though modified by translational types of slip at higher deformation. A valuable new insight is also provided into many observations on crystal growth and properties, especially the nature, determining conditions, stability and disorientation of crystals growing epitaxially on single crystal substrates, and into the nature of the deformation caused by unidirectional abrasion of crystals. A.

548.524 : 621.396.611.21

5903. Growing quartz crystals for military needs. A. C. Walker. *Electronics*, **24**, 96–9 (*April*, 1951).

Development work following that of Nacken is described. It is based on experiments carried out at a constant temperature using a seed crystal plate in an alkaline solution at or near the critical point for water, i.e. 374°c and 3 200 lb/in². Under these conditions the solution becomes so supersaturated that crystals grow rapidly and spontaneously to form uncontrolled needles, but the growth soon stops. At higher temperatures and pressures, however, the increased density of the solution favours greater solubility, resulting in rapid but continuous growth. The autoclave used consists of a hollow shell or bomb containing a seamless steel tube. The latter is 80% filled with aqueous solution of Na_2CO_3 or NaOH. A seed crystal is hung from the top while broken pieces of pure quartz are placed at the bottom. The inner tube is sealed up and a retainer cap screwed on to the shell. The bomb is maintained for ~32 days in an insulated oven at 380°c at the top and 400°c at the bottom, the pressure being ~15 000 lb/in². During this time three CT-cut plates will take on an additional 1 lb of quartz. Generally, a rate of growth >0·025 in/day on each face can be expected. A bibliography covering the pioneer work is given. H. G. M. SPRATT (R)

548.526 : 539.27

5904. Grain growth in a texture, studied by means of electron-emission microscopy. G. W. Rathenau and G. Baas. *Physica*, **17**, 117–28 (*Feb.*, 1951).

Grain growth and secondary recrystallization in rolled face-centred NiFe alloys has been studied by electron-optical means, an image of the activated hot metal surface being formed. Grain growth in an imperfect cubic texture proved to be a discontinuous process. Almost all neighbouring grains invade quickly one grain or group of grains. Grain-boundary movement at low-energy boundaries occurs on a small scale. The high-energy parts of the boundary between a cubic crystal and its (near) twin proved to move in a direction parallel to the common (111) plane. The surface tension of the boundary between a secondary crystal and a cubic crystal which is to be absorbed is about twice the value corresponding to the surface between two cubic crystals. A.

548.53

5905. Studies in polymorphism. VI. A further investigation of the linear rate of transformation of monoclinic into rhombic sulphur. N. H. Hartshorne and M. H. Roberts. *J. Chem. Soc.* (1951) 1097–1114 (*April*).

New measurements of the rate covering the range 0–80° afford strong evidence that the activation energy

which determines the temperature coefficient of the reaction is of the same order as the heat of sublimation and not appreciably less than this as was formerly thought [Abstr. 1986 (1940)]. A possible reason for the very large pre-exponential factor ($\sim 10^7 . vd$) is discussed. This is based on a suggestion by Garner that the transformation can proceed within small homogeneous elements of volume, e.g. mosaic blocks, with a much smaller activation energy than the heat of sublimation, but that the latter amount of energy is required to bridge the discontinuity between one such element and the next, and is the rate-controlling factor. This idea receives some support from observations under the microscope which show that the advance of the interface is spasmodic, the interface continually surging forward locally at a greater rate than the average rate of advance. The microscopic study has also shown that when the interface crosses the boundary between two differently oriented monoclinic crystals, it does so without change of orientation of the rhombic phase. The transformation is thus essentially a process of crystal growth in a solid medium. A.

548.57

5906. An interferometric study of cleavage surfaces of artificially grown cyrstals of sodium chloride. S. AMELINCKX. *Phil. Mag.*, **42**, 324–7 (*April*, 1951).

Cleavage surfaces were examined by multiple-beam interferometry. Two main features are noted, namely long narrow, more or less parallel strips, and superposed on this is a secondary fine grain structure. Ag films on NaCl are found to be unstable and apparently photosensitive. The cleavage mechanism is discussed. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

5907. Suggested structures of water in inert gas hydrates. W. F. CLAUSSEN. Letter in *J. Chem. Phys.*, **19**, 259–60 (*Feb.*, 1951).

A diamond pentagonal dodecahedral lattice is proposed containing a 16-hedron void. This structure offers 2 sizes of holes, i.e. 2 hydrating numbers. J. JACOBS

548.7

5908. Lattice defects in silver bromide. H. KANZAKI. Letter in *Phys. Rev.*, **81**, 884 (*March* 1, 1951).

The specific heat of polycrystalline AgBr increases rapidly above 250°. The value for the activation energy (production of a defect pair) derived is compared with that obtained from thermal expansion measurements. A. J. KENNEDY

548.7 : 535.343–34

A new type of short wavelength absorption bond in alkali halides containing color centres. *See Abstr.* 5272

548.7 : 535.343.2–15

5909. The use of polarized infra-red radiation in the study of crystal structure. E. J. AMBROSE, A. ELLIOTT AND R. B. TEMPLE. *Proc. Roy. Soc. A*, **206**, 192–206 (*April* 10, 1951).

The relation between infra-red dichroism of a band produced by co-valent linkages in a crystal, and the direction of the changing dipole moment is treated quantitatively. Observations of dichroism have been made in a crystalline layer of adipic acid, and in a single crystal of diketopiperazine. The results agree with the crystal structures of the materials as derived from X-ray spectra, when the usual assumptions as to valency angles are made in calculating NH, CH and OH bond directions. The stretching mode frequencies of NH in diketopiperazine consist of at least six peaks, all showing exactly the same dichroism. The breadth of the OH band in adipic acid can perhaps be explained as being due to rotation of the OH group around the single bond CO link. A.

548.7 : 539.373

The equilibrium of linear arrays of dislocations. *See Abstr.* 5827

548.73/.74

5910. Facts about crystals. K. LONSDALE. *Sci. Progr.*, **39**, 209–24 (*April*, 1951).

A brief account of information obtained from X-ray and neutron diffraction studies. Subjects included are: antiferromagnetism; structure of ice; randomness of structure; clathrate compounds; complex organic and mineral structures. 26 refs.

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 5819–23

548.733

5911. Design for an equi-inclination Weissenberg goniometer. A. MCL. MATHIESON. *J. Sci. Instrum.*, **28**, 112–14 (*April*, 1951).

Construction of the main parts of the instrument from Hiduminium castings results in a unit which is light in weight (19 lb) and easily handled. Use of a guide-rail assembly allows considerable reduction in the dimensions of the base. Design of the film-holder as a section of a cylinder facilitates the loading of single films, or packs of 4 or 5. The method of reversal of drive is novel. A.

548.733 : 536.48

5912. An improved device for X-ray diffraction studies at low temperatures. B. POST, R. S. SCHWARTZ AND I. FANKUCHEN. Note in *Rev. Sci. Instrum.*, **22**, 218–19 (*March*, 1951).

Device can be used, without icing-up, down to liquid-nitrogen temperatures. A. R. STOKES

549.734

5913. A new X-ray diffraction method for studying imperfections of crystal structure in polycrystalline specimens. A. J. REIS, J. J. SLADE, JR. AND S. WEISSMANN. *J. Appl. Phys.*, **22**, 665–72 (*May*, 1951).

548.734 : 518.5

On a new device for the summation by an optical method of Fourier series in several dimensions. *See Abstr.* 5002

548.734.4

5914. Missing reflections in [X-ray] oscillation photographs of large crystals. E. MENZEL. *Z. angew. Phys.*, **3** (*No.* 1) 21–2 (1951) *In German.*

Geometrical conditions for obscuration of the reflections are worked out. A. R. STOKES

548.734.8

5915. Variance of X-ray intensities. A. J. C. WILSON. Letter in *Research, Lond.*, **4**, 141–2 (*March*, 1951).

See Abstr. 6562 (1949). The mean-square deviation of the intensities from their mean $\langle(I - \Sigma)^2\rangle$, has the value $\Sigma^2 - \Sigma_4$ for a non-centrosymmetric crystal and $2\Sigma^2 - 3\Sigma_4$ for a centrosymmetric, where Σ_4 is the sum of the fourth powers of the atomic scattering factors. This provides a further test for centrosymmetry, and the excess of the experimental above the theoretical values may give an indication of the experimental errors. A. J. C. WILSON

548.735.44 : 518.5

5916. Investigations on Fourier synthesis of the charge distribution in crystals. Volume II. Table of phase factors for crystallographic two-dimensional Fourier synthesis of a fortyeight-point network, containing 91 tables of the function $\cos 2\pi hx \cos 2\pi ky$. W. DE BEAUCLAIR AND U. SINGOWITZ. *Berlin, Akademie-Verlag* (1949) 93 *un-numbered leaves. In German.*

See Abstr. 3522 (1950) for part I. The tables are arranged for the calculation, point by point, of the electron density to 5 significant figures at 48×48 points in the unit cell. Further tables of $\sin 2\pi hx \sin 2\pi ky$ would be necessary if $F(hkO) \neq F(h\bar{k}O)$. A. J. C. WILSON

548.735.46

5917. The determination of crystal structures from X-ray data without a knowledge of the phases of the Fourier coefficients. D. MCLACHLAN, JR. *Proc. Nat. Acad. Sci., Wash.*, **37**, 115–24 (*Feb.*, 1951).

Methods of modifying the Patterson synthesis so that peaks corresponding to the true atomic positions become more readily visible are discussed from a general standpoint. One method consists of translating the synthesis by a peak vector and adding to the original; this enhances certain peaks corresponding to true atomic positions, and can be carried out either directly or by means of a new synthesis with modified coefficients $F_M = |F_h|^2\{1 + \exp(2\pi i\mathbf{h} \cdot \mathbf{r})\}$, where $\mathbf{r}$ is the translation. Alternatively the synthesis and the translated synthesis may be multiplied, which has the advantage of reducing the background on which the enhanced peaks appear. The modified coefficients are more complicated. Compare Abstr. 7613, 9125 (1950), 3206 (1951). A. J. C. WILSON

548.736

5918. Standard X-ray diffraction patterns. H. E. SWANSON AND E. TATGE. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 318–27 (*April*, 1951).

The equipment used in obtaining the data presented here comprises a Geiger-counter spectrometer with a 180° arc calibrated with the calculated patterns of substances whose lattice constants are known with high precision. Separate charts are prepared to obtain data for interplanar spacing and intensity measurements so that special attention can be paid to mounting the sample for the best results in each case. Tables are included to compare the patterns with those recorded in the literature. Tables and discussion follow for X-ray diffraction data based on four compounds not listed in the American Society for Testing Materials file and on four represented there. The patterns of zinc borate, ZnB_2O_4; selenium oxide, SeO_2; magnesium silicate (forsterite), Mg_2SiO_4; and magnesium tungstate, $MgWO_4$, are recommended as additions to the file. The patterns of strontium nitrate, $Sr(NO_3)_2$; barium nitrate, $Ba(NO_3)_2$; lead fluochloride (matlockite), PbFCl; and mercuric chloride, $HgCl_2$, are recommended to replace the present patterns in the file. A.

548.736.3

5919. The space group of the σ-FeCr crystal structure. B. G. BERGMAN AND D. P. SHOEMAKER. Letter in *J. Chem. Phys.*, **19**, 515 (*April*, 1951).

Quantitative intensity data demands that all the atoms be confined to parallel planes normal to c and $c_0/4$ apart. This conforms to the holohedral structure previously proposed by the authors [*J. Amer. Chem. Soc.*, **72**, 5793 (*Dec.*, 1950)]. Other data suggests that σ-CoCr and β-uranium also have this structure. A. J. KENNEDY

548.736.3

5920. The crystal structure of indium monobromide. N. C. STEPHENSON AND D. P. MELLOR. *Aust. J. Sci. Res. A*, **3**, 581–6 (*Dec.*, 1950).

Powder and complete rotation photographs. Unit cell: $a = 4{\cdot}46 \pm 0{\cdot}005$, $b = 12{\cdot}39 \pm 0{\cdot}02$, $c = 4{\cdot}73 \pm 0{\cdot}01$ Å, four molecules per cell. Space group D_{2h}^{17}–*Cmcm*. The structure is a layer structure isomorphous with that of TlI. Each I has five Br atoms arranged about it at the corners of a rectangular pyramid with one In–Br Bond of 2·80 Å and four In–Br bonds of 3·29 Å. I atoms are similarly arranged about Br atoms. A.

548.736.3

5921. Lattice defects in silver bromide. C. R. BERRY. *Phys. Rev.*, **82**, 422–3 (*May* 1, 1951).

Measurements have been made of the lattice parameter at room temperature and in the range from about 350 to 420°C. The results are compared with the values obtained on the basis of two contrary assumptions: first, that the lattice expansion is identical with the external expansion measured by Strelkow; and second, that some of the external increase in volume is caused by formation of vacancies, the resultant parameter being that estimated by Lawson. Within experimental error, the measured curve agrees with the first assumption, which is equivalent to the assumption that no Schottky defects have formed. Since it is known from ionic conductivity measurements that there are about 2% of defects at temperatures near 420°C, it is concluded that these are Frenkel defects. However, the magnitude of the errors involved in the measurements is such that the existence of a small number (about 10% of the total) of Schottky defects cannot be entirely precluded. A.

548.736.3

5922. X-ray measurement of long-range order in β-AgZn. L. MULDAWER. *J. Appl. Phys.*, **22**, 663–5 (*May*, 1951).

The replacement of small amounts of Ag by Au in AgZn raises the critical temperature for long-range ordering and completely suppresses the zeta-phase. Measurements of T_c were made in a high temperature

camera using several percentages of Au. Extrapolation to zero content of Au gives $T_c = 272°C$ for pure AgZn. The variation of long-range order with temperature was determined from measurements of the integrated intensity of the (111) superstructure line, using a compact of filings of composition 3·5 Au, 46·5 Ag and 50·0 Zn. The variation is similar to that found in β-brass, and is in agreement with the predictions of the Cowley theory. A.

548.736.4

5923. The crystal structure of sulfur dioxide. E. KANDA AND T. SUGAWARA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 216–28 (*April*, 1950).

Orthorhombic, probably *Aba*, $a = 6·03$, $b = 5·94$, $c = 6·08$ A(?) at 95°K, $Z = 4$, 4S in (*a*) with $z = 0·00$, 8·0 in (*b*) with $x = 0·151$, $y = 0·141$, $z = 0·117$, from powder photographs. A. J. C. WILSON

548.736.4

5924. Sodium stannate, $Na_2Sn(OH)_6$. J. KRC, JR. *Analyt. Chem.*, **23**, 675–6 (*April*, 1951).

Crystal morphology, cell dimensions, density, optical properties and fusion data are given.

548.736.4

5925. The structures of inorganic oxy-acids: the crystal structure of selenic acid [anhydrous]. M. BAILEY AND A. F. WELLS. *J. Chem. Soc.* (1951) 968–73 (*April*).

Orthorhombic: $a = 8·52$, $b = 8·17$, $c = 4·61$ Å, 4 molecules in the unit cell. Space-group taken as *P*2,2,2, though three very weak reflections (700, 090 and 001) were observed on heavily-exposed photographs. Tetrahedral SeO_4 groups (mean Se–O, 1·61 Å), each joined by four O–H–O bonds (lengths 2·61 and 2·68 Å) to four neighbouring groups to form puckered layers parallel to (100). A.

548.736.5

5926. Crystal structure of nitric acid with three water molecules. V. LUZZATI. *C.R. Acad. Sci., Paris*, **232**, 1428–30 (*April* 9, 1951) *In French.*

Unit cell dimensions, atomic co-ordinates, bond lengths and description of structure are given. The unit cell is orthorhombic and contains four molecules. A. R. STOKES

548.737

5927. Unit cell and space-group of sodium tartrate $Na_2C_4H_4O_6$, $2H_2O$. A. RADHAKRISHNAN AND G. N. RAMACHANDRAN. *Curr. Sci.*, **20**, 36 (*Feb.*, 1951).

Orthorhombic, $P2_12_12_1$, $a = 11·49$, $b = 14·67$, $c = 4·97$ Å, $Z = 4$. A. J. C. WILSON

548.737

5928. X-ray crystallographic data on the mandelic acids. S. FURBERG. Letter in *Research, Lond.*, **4**, 192 (*April*, 1951).

Unit-cell dimensions, space group, density and birefringence for racemic- and *d*-mandelic acids. A. R. STOKES

548.74

5929. On the structure of the streaks in the Kossel–Möllenstedt electron interference patterns with a convergent beam. I. E. FUES AND E. H. WAGNER. *Z. Naturforsch.*, **6a**, 1–12 (*Jan.*, 1951) *In German.*

A generalization of Fues's earlier theory, applicable to any direction of incidence of the electron beam and any crystal structure. J. THEWLIS

548.74

5930. Epitaxy of silver on (110) and (111) faces of rock salt. L. BRÚ AND K. G. GHARPUREY. *An. Real. Soc. Esp. Fis. y Quim.*, **47A**, 101–10 (*March–April*, 1951) *In Spanish.*

Ag films evaporated on to heated NaCl were examined by electron diffraction. The Ag crystals adopt the same orientation as the substrate, with twinning on {111} planes, although there is a large difference (~30%) in lattice parameter. The resultant stresses appear to be relieved by "rotational slip" about 110 directions. A. J. C. WILSON

548.74

5931. Some experimental measurements of the inner potentials of various crystals. V. F. G. TULL. *Proc. Roy. Soc. A*, **206**, 219–32 (*April* 10, 1951).

Although a large number of measurements of inner potential have been made in the past, the results have, on the whole, been far from consistent. These measurements were made by electron diffraction methods, and one possible reason for the lack of consistency is that, owing to the very limited penetration of the electron beam, the nature of the surface layers of the specimen will play an important part in the results obtained. In particular, if the specimen is a single crystal, there arises the possibility that different results will be obtained if the measurements are made using crystallographically different surfaces of the crystal. This possibility was examined experimentally and, for the materials used, no difference was found in the results obtained from different surfaces of the same crystal. Measurements were also made, using fast electrons (60 kV), of the inner potentials of metal crystals, and it was found that consistent results could be obtained in all cases if suitable experimental precautions were observed. It was also found that the presence of a thin contaminating layer on the surface (e.g. an oxide layer) did not affect the results provided the electron beam was able to penetrate the first few atomic layers of the specimen itself. A.

548.74

5932. The calculation of the inner potential of a crystal. V. F. G. TULL. *Proc. Roy. Soc. A*, **206**, 232–41 (*April* 10, 1951).

Although a number of calculations of the inner potential have been made in the past for various crystals, the results have not been entirely satisfactory, and in some cases widely divergent values for the same substance were published by different authors. In the present work, a number of these calculations are examined and possible sources of error discussed. It is shown that electron distribution charts and curves obtained experimentally are not suitable for the calculation of inner potential, and an exponential approximation for atomic scattering factors is given which is found to be more reliable for this purpose. A simple modification of the electron distribution curves obtained from these atomic scattering factors is described; this is applied when the atoms are bound in a crystal lattice, thus enabling the inner potential of the crystal to be calculated. The results of a number of calculations based on this method are given and compared with the experimental values, the agreement being satisfactory. A.

GEOPHYSICS 55

550.31 : 525.2

5933. Dynamic effects of a liquid core. II. H. JEFFREYS. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 5) 460–6 (1950).

Abstr. 6868 (1950), part I. An approximate method is applied to the Eulerian and forced nutations to take account of possible effects of differences of density within the earth's core. It is found that all such effects are adequately taken into account by replacing the actual core by a homogeneous one with the same moments of inertia. A.

550.34

5934. A study of the energy content of the seismic waves P and pP. H. M. MOONEY. *Bull. Seism. Soc. Amer.*, **41**, 13–30 (*Jan.*, 1951).

The energy observed in the seismic waves P and pP in a large number of earthquakes is compared, by means of two partly independent methods, with the theoretical energy calculated from a standard equation. The results are analysed, depth of focus, distance from epicentre to observing station, geographical location of epicentre, and azimuth from station being used as variables. A.

550.834 : 534.143 : 621.395.62

5935. An electromechanical source of elastic waves in the ground. F. F. EVISON. *Proc. Phys. Soc., Lond. B*, **64**, 311–22 (*April*, 1951).

A large moving-coil transducer is described which, when attached rigidly to rock, radiates sinusoidal vibrations of controllable amplitude, frequency and duration. The operation of the vibrator is analysed in detail by the method of electromechanical analogy. For experiments in a chalk-mine, energy at each of the frequencies 300, 600 and 1 000 c/s was radiated in the form of a square-enveloped pulse, of 20 msec duration. Vibrations were detected in the rock by means of a piezoelectric microphone, amplifiers and an oscillograph, with an overall magnification of about 10^9. Oscillograms show the complex disturbances produced by the arrival of direct and reflected energy, at distances out to the limit of the mine at 450 ft. Measurements of amplitude at 130 ft are used to examine the mechanism of the transfer of energy from the vibrator to the rock. The power radiated was about 0·05 W at 600 c/s, of which about one-sixth was in the compressional mode and five-sixths in the shear mode; but this power may readily be increased. A.

550.93 : 551.510.41 : 539.16

5936. K^{40} and the age of the atmosphere. K. F. CHACKETT. Letter in *Phys. Rev.*, **81**, 1057 (*March* 15, 1951).

The age is estimated at $3 \cdot 1$ to $3 \cdot 5 \times 10^9$ yrs from the amount of K^{40} in the earth and the amount of A^{40} in the atmosphere.

ATMOSPHERE . METEOROLOGY 551.5

551.510.535

5937. Rapid changes in the ionosphere. H. W. WELLS. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 369–70 (1950).

Short note reporting some ionospheric observations made with a fast sweep recorder which indicated rapid ionospheric changes during disturbed periods. Clouds of ionization appear to move from levels of 800–900 km to 300–400 km with velocities of 1 to 2 km/sec. The appearance of sporadic *E* ionization seems to be preceded by small but noticeable disturbances in region *F*. W. J. G. BEYNON

551.510.535

5938. High-speed ionospheric recording technique. H. W. WELLS. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 370–1 (1950).

Brief outline description of a high-speed multi-frequency ionospheric recorder covering the frequency range 1–20 Mc/s in a few seconds (see also preceding Abstr.). W. J. G. BEYNON

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 5612

551.578.1

5939. An appraisal of cloud seeding as a means of increasing precipitation. H. G. HOUGHTON. *Bull. Amer. Met. Soc.*, **32**, 39–46 (*Feb.*, 1951).

The results of cloud-seeding experiments are reviewed briefly and it is concluded that, taken alone, they do not constitute an adequate basis for a sound appraisal of the potentialities of the cloud seeding techniques. An attempt is made to extend and supplement the observational evidence with the aid of existing knowledge of cloud physics and synoptic meteorology. On the basis of the analysis of the physical processes and general knowledge of synoptic meteorology it is concluded that it is unlikely that cloud seeding will cause large-scale effects. A.

551.578.1

5940. Effect of sunlight on the action of silver iodide particles as sublimation nuclei. S. E. REYNOLDS, W. HUME, II, B. VONNEGUT AND V. J. SCHAEFER. *Bull. Amer. Met. Soc.*, **32**, 47 (*Feb.*, 1951).

551.594 : 539.16.08

5941. Research into the radioactivity of free air. H. GARRIGUE. *C.R. Acad. Sci., Paris*, **232**, 722–4 (*Feb.* 19, 1951) *In French.*

Earlier work has been continued with measurements at ground level heights 300 m and 1 500 m and in a specially equipped aircraft up to 5 670 m, of the radon and thorium content. During flight only the substance A ("corps A," so far unidentified) with apparent period 20 to 30 hr was again detected [Abstr. 8927 (1950)]. W. C. A. HUTCHINSON

551.594 : 539.16.08

5942. Renewed outbreak of anomalies in the radioactivity of the atmosphere at medium altitudes. H. GARRIGUE. *C.R. Acad. Sci., Paris*, **232**, 827–9 (*Feb.* 26, 1951) *In French.*

Measurements made in the flying laboratory up to 3 500 m during January 1951 showed a long period activity due to substance A (see preceding Abstr.) three times more intense than the maximum of all observations since January 1950. W. C. A. HUTCHINSON

551.594 : 539.16.08

5943. The inflow of radioactive air of atomic origin and its influence on atmospheric precipitation. H.

GARRIGUE. *C.R. Acad. Sci., Paris*, **232**, 1003–4 (*March* 5, 1951) *In French.*

See preceding Abstr. The rapid fall of activity from a maximum to zero immediately following heavy rain in February 1951 is interpreted as evidence that the radioactive nuclei form condensation nuclei. Contamination from large atomic explosions will be localized provided a period of rain follows, but the nuclei diffused in the stratosphere will produce a long-term and widespread effect on meteorological phenomena. W. C. A. HUTCHINSON

551.594.221 : 537.523.4

The electrical processes in the intervals between the strokes of a lightning discharge. *See Abstr.* 5432

551.594.221 : 538.566.2 : 621.396.9

5944. A radar echo from lightning. I. C. BROWN. Letter in *Nature, Lond.*, **167**, 438 (*March* 17, 1951).

A radar echo of unusual intensity was found to coincide with a strong positive field change. It is estimated that the reflection occurred on a lightning channel with at least 5×10^{13} electrons per cm length. R. H. GOLDE (R)

551.594.6 : 621.396.822

5945. The statistical action of atmospherics on a receiver tuned to 27 kc/s. F. CARBENAY. *C.R. Acad. Sci., Paris*, **232**, 949–50 (*March* 5, 1951) *In French.*

A note on some results obtained using the 27 kc/s atmospheric recorder already described [Abstr. 7667 (A), 3557 (B) (1950)]. The value of the atmospheric recorder sensitivity index previously defined is briefly discussed in relation to the receiver bandwidth. It is shown that the mean level of atmospherics as recorded by the equipment is independent of bandwidth provided that this index is maintained constant. W. J. G. BEYNON

BIOLOGY 57/59

578 : 539.16

5946. A method of carrying out *in vivo* tracer measurements with radioactive isotopes. H. A. KÜNKEL. Letter in *Experientia*, **7** (*No.* 4) 154–5 (1951) *In German.*

Using a radioactive tracer which emits two or more γ quanta per decay (e.g. Na^{24}) the measurement is described of the radioactivity of an exactly defined part of a greater system. Two fixed, lead-collimated counters, are mutually angled at 90°. Their "beams" converge on the part whose activity is to be measured. The radioactivity in this defined volume is proportional to the number of coincidences recorded between the counters. False coincidences will occur due to the general level of surrounding activity and the finite resolving time of the counters. With scintillation counters, errors become reasonably small. D. V. MABBS

578.088.2 : 534.23

Physical factors involved in ultrasonically induced changes in binary systems. II. Amplitude duration relations and the effect of hydrostatic pressure for nerve tissue. *See Abstr.* 5189

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843

5947. The informational capacity of the human eye. H. JACOBSON. *Science*, **113**, 292–3 (*March* 16, 1951)

Other workers' data on visual acuity both in the foveal and the peripheral regions of the human eye, the time of integration of bright signals viewed centrally, and the variation of the fusion-frequency with the retinal meridian are used to compute the number of "binary digits" (bits). The maximum comes to $4{\cdot}3 \times 10^6$ bits/sec. This is shown to be 430 times as good as the corresponding result for the ear. The difference in the number of nerve-fibres in the auditory and the optic nerves respectively cannot wholly account for this factor. R. A. WEALE

612.843.31

5948. A model of the events occurring in the retina as derived from the facts of colour vision. H. E. J. NEUGEBAUER. *Phys. Bl., No.* 1, 20–30 (1951) *In German.*

The model of processes taking place in the retina is based exclusively on considerations of photochemistry with hardly any reference to nervous factors. Yet another compromise is attempted between the Young–Helmholtz and Hering's theories. It is suggested that free-pigment molecules, i.e. those not tied to the cones and contained in the "pigment factory," can replace brightness mechanisms as postulated by Luther and v. Studnitz. Four schematic diagrams and graphs are given. R. A. WEALE

612.843.611

5949. The influence of surround brightness and short wave components of radiation on dark adaptation. M. J. ZIGLER, E. WOLF AND E. S. KING. *J. Opt. Soc. Amer.*, **41**, 354–9 (*May*, 1951).

Dark adaptation functions were determined by presenting a 2° square test field in the temporal parafovea, or a 1·3° field in the fovea, against backgrounds or surround luminances varying in brightness from complete darkness to 40 millilamberts. The test field was composed of parallel, equally spaced dark and light vertical bars, and presented in the form of flashes of 0·04 sec. As surround luminance is systematically increased the total extent of adaptation, the relative participation of rods and cones, and the transition from cone to rod function vary as a function of background luminance. Pre-exposure to a light source emitting radiation from 2 850 to 4 100 Å in addition to white light has an inhibitory effect on the sensitivity of the retinal receptors which is evident in higher excitation thresholds as compared with those obtained when the ultraviolet is screened from the pre-exposure source. The ultraviolet action which

previously was only shown for the rods is also found in foveal and parafoveal cones, when, owing to the presence of a surround luminance, the rods are prevented from entering into action, and the range of adaptation is limited to levels above threshold for cone excitation. A.

612.843.721

5950. The role of convergence in stereoscopic vision. W. D. WRIGHT. *Proc. Phys. Soc., Lond. B*, **64**, 289–97 (*April*, 1951).

An apparatus for testing stereoscopic acuity has been constructed in which the distance of a reference aperture P is compared with that of a test aperture Q selected from one of a tapering series of aperture plates. The apertures are seen as illuminated disks in a black field and all monocular aids to depth perception are eliminated. The observer has to state whether Q is in front of or behind P, and the acuity is derived by plotting the percentage estimates against the distance of Q. Observations have been made for condition A, in which the observer is allowed to look first at P and then at Q, and for condition B, in which the observer fixates on P and views Q extra-foveally. From a comparison of the acuity for the two conditions for various angular separations θ between P and Q, deductions can be made about the relative contributions to stereoscopic vision of convergence and retinal disparity. The results suggest that convergence makes a significant contribution and has become the predominant factor at $\theta = 20°$. For $\theta = 14°$, the acuity for condition A is due entirely to convergence, since the blind spot interferes with the retinal disparity. Tests with flash exposures suggest that small eye movements do not play any important part in depth perception. The presence of depth perception under conditions of gross diplopia was confirmed, indicating that fusion is not an essential item for three-dimensional vision. A.

612.845.5

5951. Physiological mechanisms of color blindness. M. EBE, K. ISOBE AND K. MOTOKAWA. *Science*, **113**, 353–4 (*March* 30, 1951).

An electrical phosphene was used to measure the time-variation of the excitability of the eyes of anomalous and red-green blind subjects after 2 sec exposure to light of different wavelengths. The stimulus subtended an angle of 2°, and was viewed foveally. Apart from red, green and blue processes, a specific yellow process, absent from the foveae of normal observers, was discovered. No estimate of the accuracy of the results is given. The trichromatic theory is challenged. Three figs. are presented.

R. A. WEALE

612.85

5952. Determination of the effects of dissipation in the cochlear partition by means of a network representing the basilar membrane. B. P. BOGERT. *J. Acoust. Soc. Amer.*, **23**, 151–4 (*March*, 1951).

Results are given of measurements made on a 175-section network representing the basilar membrane, which was modified to include the effects of dissipation in the cochlear partition. The results show that the dynamical theory of the cochlea, when dissipation is considered, is in good agreement with experimental evidence. A.

612.85

5953. Electrical excitation of nerves in the skin at audiofrequencies. A. B. ANDERSON AND W. A. MUNSON. *J. Acoust. Soc. Amer.*, **23**, 155–9 (*March*, 1951).

Report of results obtained in preliminary tests of perception of signals applied directly to the skin in the form of electrical potentials. The lowest signal level that could be felt and the highest level that could be applied without extreme discomfort to the observers were determined for sine wave potentials ranging from 100 to 10 000 c/s. The difference between the lowest and highest levels was about 25 db over this frequency range. Difference limen measurements for intensity and frequency showed that intensity discrimination is not greatly different from what it is for hearing, but the ear is vastly superior in the matter of frequency discrimination. A.

612.85

5954. Some remarks on the modern status of auditory theory. E. G. WEVER. *J. Acoust. Soc. Amer.*, **23**, 287–9 (*May*, 1951).

A discussion of the problem of the relative importance of place and frequency principles. It is concluded that for the low tones whose patterns are broad the place principle contributes little or nothing to pitch discrimination, and the frequency principle has to serve this function alone. A study of the evolution of the ear brings out the relative roles of the principles. The lower forms, which exhibit a fair degree of tonal discrimination, possess an ear of exceeding simplicity, an otic sac in which there is little evidence of mechanical differentiation. It follows that these primitive ears must operate as frequency receptors and that in the history of the ear the frequency principle came first as the basis of tonal reception, and was only sometime later in the course of evolutionary development joined by the place principle. A.

612.85

5955. Place mechanisms of auditory frequency analysis. W. H. HUGGINS AND J. C. R. LICKLIDER. *J. Acoust. Soc. Amer.*, **23**, 290–9 (*May*, 1951).

The hypotheses involve mechanisms, both mechanical and neural, for sharpening the analysis inherent in the cochlear transformation from frequency of stimulation to locus of vibration. These mechanisms operate in the domain of place—they are place theories that supplement the classical place theory. A.

612.85 : 534.79

5956. Some recent work on auditory adaptation and its relationship to the loudness recruitment phenomenon. C. S. HALLPIKE AND J. D. HOOD. *J. Acoust. Soc. Amer.*, **23**, 270–4 (*May*, 1951).

Two outstanding characteristics of the adapted state are defined: "on-effect normality" and "relapse." Both resemble very closely those described by Matthews in the case of adaptation occurring in the muscle stretch receptors of the frog. Further studies in a number of human subjects show that both of

hese characteristics are exhibited regularly by the nadapted hair cell responses of individuals suffering rom degenerative changes of the hair cells. The xperimental findings are thought to indicate that oudness recruitment is one element of a complex isturbance of cochlear function due to disease or njury of specific elements of the cochlear sensory pparatus, namely the hair cells of Corti's organ. A.

614.898

957. The use of photographic films for monitoring tray X-rays and gamma-rays. R. B. WILSEY. *Radiology*, **56**, 229–41 (*Feb.*, 1951).

The relative merits of the monitoring of stray onization with films and ionization chambers are riefly enumerated, and the paper then gives details f film calibration, sensitivity, etc., for a range of - and gamma-ray wavelengths and for certain eta-rays. Special attention is given to monitoring 1 220 kV, 1 000–2 000 kV therapy, in diagnostic adiology and with radium gamma rays. The use of a-covered films and the lead cross packet are also escribed, with reference in the latter case to the onitoring of U radiations. J. D. CRAGGS

614.898

958. International recommendations on radiological protection (July, 1950). *Amer. J. Roentgenol. Radium Ther.*, **65**, 603–9 (*April*, 1951).

For abstract see Abstr. 4013 (1951).

614.898

959. Supplement on maximum permissible amounts of radioactive isotopes. International Commission on Radiological Protection (July, 1950). *Amer. J. Roentgenol. Radium Ther.*, **65**, 610–14 (*April*, 1951).

Firm recommendations were not given by the Radiological Protection Commission. Those quoted here are at present used in U.S.A., Canada and Great Britain. Maximum permissible amounts of natural and artificial radioactive substances, entering the body by ingestion or inhalation, are estimated for commonly used materials. These are summarized in a comprehensive table. Weights of the organs of a 70 kg man, and their overall chemical composition are given, together with details of the human water-balance and respiration. A table of the relative biological efficiency of ionizing radiations is appended. D. V. MABBS

616–073.75

5960. The intensification of X-ray fluorescent images. W. S. LUSBY. *Elect. Engng, N.Y.*, **70**, 292–6 (*April*, 1951).

A description is given of the present form of Coltman fluoroscopic image amplifier, two specimens of which are now in clinical use. Limitations in intensifying a fluorescent X-ray image, and the variation of visual acuity with brightness, are discussed. X-rays leaving the patient impinge on a fluorescent screen of 5 in dia. at one end of a highly-evacuated glass vessel. Light photons thus produced eject electrons from a caesium-antimony surface close to the screen. These electrons are accelerated by an electron-optical system through 30 kV, and focused to a fluorescent image of 1 in dia. Optical magnification, without loss of brightness, makes a total intensity amplification of 100. Desirable properties of image amplifiers are discussed under the headings of brightness, definition and contrast. Experiments in screening with body phantoms showed that the minimum perceptible mesh size is only 70% coarser for this apparatus than for radiography. Visualization of a 3% thickness difference was demonstrated in an 8 in abdomen. D. V. MABBS

PHOTOGRAPHY 77

771.35

961. A window for under-water photography. . IVANOFF. *C.R. Acad. Sci., Paris*, **232**, 1193–4 *March* 19, 1951) *In French.*

Plane-parallel windows for under-water photo-raphy, reduce the field of view and destroy per-pective. A window, consisting of two separated nses corrected for colour and astigmatism, can be sed with a normal lens to increase the field of view nd give true perspective without affecting the efinition. R. W. FISH

771.534

962. On the sensitometry of light-sensitive layers. . SPÄTH. *Z. wiss. Photogr.*, **45** (*No.* 10–12) 193–212 950) *In German.*

The S-shaped curve relating exposure and photo-aphic density is similar to curves expressing many her statistical phenomena where one variable has a nite limit and the other has no limit. The derivation f this type of curve is examined mathematically, ith particular reference to the use of non-linear co-ordinates. Methods of measuring emulsion speed from the curve are discussed. S. T. HENDERSON

771.534

5963. Sensitization and desensitization of a silver chloride or silver bromide emulsion by organic compounds which are built up from at least one pyrimidine or iminazole ring, or from both rings. H. GRASSMANN. *Z. wiss. Photogr.*, **45** (*No.* 10–12) 233–52 (1950) *In German.*

The light sensitivity of AgCl and AgBr, either without gelatine, or in gelatine emulsions prepared under certain conditions, is increased by substances of the pyrimidine and purine classes. The effect is ascribed to tautomerism which allows the attachment of Ag halide to the enol form of the grouping N=C—N=C. Though this grouping is possible in iminazole derivatives, these give variable results with Ag halides, but sensitize AgCl emulsions, whereas AgBr emulsions are unaffected or desensitized. Lysidine, a highly alkaline base, sensitizes the free halides and AgBr emulsions, but may

desensitize AgCl emulsions or produce fog according to its concentration, similar effects being produced by caustic alkalis. S. T. HENDERSON

771.534.5

5964. Paucity of quanta rendering a silver halide grain developable. L. SILBERSTEIN. *J. Franklin Inst.*, **251**, 263–8 (*Feb.*, 1951).

The density produced in a photographic emulsion by a given exposure can be expressed in terms of the number of grains available and the number of quanta required to make one grain developable. The assumptions are made that all grains of the emulsion require the same number r quanta to make them developable and that they all have the same intrinsic sensitivity ε. For visible light exposures $r = 2$ or 3 and for X-ray exposures $r = 1$. It is shown that these small values of r are not due to the initial assumptions and that a dispersion of the values of ε and r among the grains cannot lead to larger values of r. It is also shown that if an observed sensitometric curve can be described in terms of the parameter r, such description is complete. A. C. COATES

771.534.5

5965. Macroscopic sensitometry, opacity, and photographic density, specular and diffuse. L. SILBERSTEIN. *J. Franklin Inst.*, **251**, 359–84 (*March*, 1951).

Equations relating photographic density to a function of exposure are developed from the quantum theory of exposure for any quantum efficiency, r. Four types of emulsion are discussed: (i) uniform (grain-size equal); (ii) exponential (grain-size/frequency follows simple exptl. curve); (iii) normal (Gaussian grain-size/frequency curve); and (iv) emulsions having any size-frequency distribution of grains. It is shown that type (ii) emulsions yield a family of quantic curves ($r = 1$, 2, 3) which closely resemble the sensitometric curves for practical emulsion types. D. R. BARBER

771.534.55

5966. Variation of the dimensions of photographic images as a function of exposure. M. T. VIGÓN. *An. Real. Soc. Esp. Fis. y Quím.*, **47A**, 75–88 (*March–April*, 1951) *In Spanish.*

The photographic image of a straight-edged slot in direct contact with the photographic emulsion will show a blurred outline. This is due to the optical inhomogeneity of the light-sensitive grains, resulting in diffusion. The method is described by which the influence of the photographic emulsion and the effect of varying dimensions of the line raster have been investigated. It is shown that this method can be used to obtain values of the turbidity of photographic emulsions far in excess of any accuracy obtained with other, more standard, methods. The lateral distribution of light (scatter) in the emulsion is expressed by a formula the value of which was 0·46 for the emulsion under investigation. Contra to the findings of other investigators, the auth concludes that turbidity measurements are n influenced by the fact that the values of the variatic of the width Δa_f of a line in the photographic ima ($\Delta a_f = f(\log E)$ where E is exposure) which t author has used are < the real values. This justifi the use of the method described through the increas accuracy in the determination of the limit of t photographic image. W. SUMM

778

5967. The processing of thick photographic emulsion A. D. DAINTON, A. R. GATTIKER AND W. O. LOC *Phil. Mag.*, **42**, 396–413 (*April*, 1951).

An attempt has been made to determine sati factory processing conditions for Ilford G5 electro sensitive emulsions up to 600 μ in thickness. T penetration and temperature characteristics of met hydroquinone, *p*-aminophenol, and *p*-diaminophen developers have been investigated. The observatio show that a *p*-diaminophenol developer gives sati factory results and a suitable procedure for processi is described. In addition the problems of fixin washing and drying, have been studied.

778.

5968. Progress in gamma radiography. *Atomic Lond.*, **2**, 112–18 (*April*, 1951).

The use of Co^{60}, Ta^{182}, and Ir^{192} for industri radiography is discussed, with details of protecti holders and safety precautions. F. T. FARM

778.

5969. Brightnesses of fine detail in air photograph P. D. CARMAN AND R. A. F. CARRUTHERS. *J. Op Soc. Amer.*, 305–10 (*May*, 1951).

An airborne recording telephotometer with a fie of view of 3-min. dia. has been used in an extensi series of measurements of ground brightnesses seen from an aircraft. Results are presented for number of typical scenes. On brightness, these resul confirm previous range values and show that, reason of their frequencies, central values are mo important than extreme values. On brightne differences, these results indicate that for small deta a typical difference of log brightness is 0·08. This lower than previously believed.

778.

5970. Aircraft camera mounts—their design a testing. P. D. CARMAN AND R. A. F. CARRUTHER *J. Opt. Soc. Amer.*, **41**, 311–14 (*May*, 1951).

Methods are discussed of minimizing the effect aircraft vibration on the quality of air photograph An improved method of testing camera mounts described, and examples are given of some tests. A experimental camera mount having unusually goo vibration elimination characteristics is described.